VWG/TR-001-96

Technical Report

Video Working Group

USIS Video Imagery Technical Information

Version 1.0

22 November 1996

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1. INTRODUCTION

1.1. Acknowledgments

This document is a compilation of information from a wide variety of sources, ranging from Department of Defense (DoD) and Intelligence Community (IC) documents to Video Working Group (VWG) and VWG subgroup participants.

1.2. Purpose

This technical report provides an end-to-end systems engineering view of video imagery in the United States Imagery System (USIS) to provide a baseline for interaction with the DoD and the IC. It is produced and configuration-controlled by the VWG, a working group of the Imagery Standards Management Committee (ISMC). Specific information sources are listed in Section 3.

This document provides a much-needed centralized repository to consolidate and publicize the VWG position on video issues and implementations. The VWG is committed to ensuring interoperability and avoiding stovepiped video implementations. These criteria must be foremost in any video-related implementation. This document will provide guidance on both the desired long-term goals and a migration path. This information is critical to influencing the increasing numbers of systems under development and system upgrades.

Video imagery issues are currently not fully addressed in most DoD/IC documents, including USIS documentation. Thus, another purpose for this document is to provide information suitable for generating requests for change (RFCs) to the various DoD/IC documents that will be impacted by video systems or data.

Please note that this document will require periodic updates—it is intended to capture a large amount of corporate knowledge and package it conveniently for the reader. Comments and suggestions are welcome.

1.3. Scope and Applicability

The scope of this document is to define the VWG view of USIS intelligence-related video imagery to be used by the DoD/IC. It will address all end-to-end aspects of video, from sensor to user. Videoteleconferencing applications are excluded and are managed in other fora.

This document will provide the roadmap for video imagery interoperability. It will also serve as a convenient repository for accumulated VWG knowledge to provide a focus for DoD/IC interaction and to feed comprehensive ”video-delta” RFCs to all appropriate DoD/IC documents.

1.4. Document Update Process

This document is meant to be a living record of VWG corporate knowledge. As such, it will capture and reflect programmatic, technical, and industry changes as they occur. This section describes the mechanics of this document and its management.

1.4.1. Frequency of Updates

This document will be updated approximately semi-annually. The frequency of updates may increase or decrease as additional information warrants. A completely new version will be released each time, with a "what's new" section to address substantive (non-editorial) revisions.

1.4.2. Document Distribution and Review

Each new version will be circulated to the DoD and Intelligence communities for review and comments. Drafts and finished versions will be distributed electronically via the Internet and Intelink. For those without electronic access, paper copies or diskettes will be provided upon request.

Comments on the document are always welcome and may be provided by e-mail, fax, phone, or writing to the VWG Chair at the National Imagery and Mapping Agency (NIMA), or at the VWG or any of its subgroup meetings. Concerns requiring discussion will normally be addressed during VWG meetings. However, technical exchange meetings (TEMs) can be scheduled to address specific issues if necessary; for example, comments on the initial release of this document will be addressed in a TEM. Contact information is provided in Table 1.

Table 1. Contact Information

	Document Locations
Internet	http://www-ismc.itsi.disa.mil/misc/ftpage.html
Intelink[•]	http://www.sparky1.cio.ic.gov/cio/products/USIS
	VWG Chair Contact Information
VWG chair:	Anthony Galassi
email:	vwg@itsi.disa.mil
	galassia@dma.gov
phone:	703-808-0892
fax:	703-808-0872
address:	National Imagery and Mapping Agency Systems Engineering Interoperability Branch (SEII) Attn: Video Working Group Chair 14675 Lee Rd. Chantilly, VA 20151-1715

1.5. Document Organization

This document is organized as follows. Section 2 lists significant changes from previous versions as the document is updated, to provide an historical summary. Applicable documents are listed and described in Section 3. Section 4 addresses technical video assumptions and issues, as well as USIS background information. A proposed video imagery conops appears in Section 5, along with the requirements and standards implications of the proposed capabilities. Proposed video-unique requirements are contained in Section 6, and the

[•] Subject to change with NIMA

standards-related implications are covered in Section 7. Potential information gaps in this document are identified in Section 8, and documents that are likely to be affected by this document are described in Section 9. The appendices contain a summary of VWG and subgroup recommendations, technical details on MPEG-2 and closed captioning, analog video unmanned aerial vehicle (UAV) system information, an extraction of services and video requirements from the TARD, and a list of acronyms and abbreviations.

2. WHAT'S NEW IN THIS VERSION?

This section addresses significant updates from previous versions of this document. When the document is updated, this section will be appended to, so its history can be traced.

2.1. Version 0.2, 9 October 1996

The initial document release for VWG coordination.

2.2. Version 1.0, 22 November 1996

Initial document release to community. Modified video quality information and added sections on tape formats and analog video standards.

3. APPLICABLE DOCUMENTS

This section lists source documents used as input to this technical report and reference documents containing additional information. Some of these documents may also be impacted by VWG recommendations. The document descriptions are paraphrased from the source documents.

3.1. Standards

3.1.1. Recommendation ITU-R BT.601-5 (REVISED) Studio encoding parameters of digital television for standard 4:3 and wide-screen 16:9 aspect ratios

Also known as CCIR 601 4:2:2 Component Video, this is the industry-standard uncompressed digital video format. It specifies the 525/59.94 scanning standard, the NTSC color encoding used in the United States, and 720 active samples per line. The number of active lines is specified in CCIR Rep. 624-4.

3.1.2. SMPTE 12M-1995 - Time and Control Code

This standard specifies the SMPTE time code representation, structure, user bit usage, modulation into the TV signal, and the relationship with Longitudinal Time Code (LTC). For USIS, the implementation used will be Drop Frame Vertical Interval Time Code (VITC).

3.1.3. ISO/IEC 13818 Generic Coding of Moving Pictures and Associated Audio

Usually referred to as MPEG-2, this standard specifies the coded representation of video data and the decoding process to reconstruct the video (Part 2), specifies the coded representation of audio data (Part 3), and the multiplexing and timing of synchronized audio, video, and private data streams (Part 1). In addition, Part 4 specifies the procedures for determining coded bitstream characteristics and for testing compliance to Parts 1-3. The MPEG-2 part names are:

ISO/IEC 13818-1	Generic Coding of Moving Pictures and Associated Audio (Systems)
ISO/IEC 13818-2	Generic Coding of Moving Pictures and Associated Audio: Video
ISO/IEC 13818-3	Generic Coding of Moving Pictures and Associated Audio: Audio
ISO/IEC 13818-4	Generic Coding of Moving Pictures and Associated Audio: Conformance

MPEG-2 Main Profile @ Main Level will be used to provide digital video compression and video, audio, and data transport. In some cases, MPEG-2 will be implemented at 4:2:2 Profile @ Main Level. MPEG-2 profile usage guidelines will be issued by the VWG.

3.1.4. SMPTE 259M-1993: 10-Bit 4:2:2 Component and $4f_{sc}$ NTSC Composite Digital Signals - Serial Digital Interface

SMPTE 259M specifies a serial digital interface for 525/59.94 digital television equipment operating with 4:2:2 component signals; the $4f_{sc}$ NTSC composite digital signals

will not be used in USIS. It is the industry standard for transporting studio-quality CCIR 601 video.

3.1.5. EIA-608 - Recommended Practice for Line 21 Data Service

This standard specifies the FCC-accepted method for closed captioning (CC). CC will be used to carry a limited amount of metadata in an analog video signal.

3.1.6. USIS Standards Profile for Imagery Archives (SPIA), Version 1.0, 20 July 1994, CIO ASD SIA 0594 0000

The SPIA was developed to support interoperability between USIS elements. It addresses information and communications services that are necessary to support the storage, query, location, and retrieval of imagery from digital product archives. Its primary use is its specification of recommended standard data directory elements to be used for imagery libraries.

3.1.7. USIS Technical Architecture Requirements document (TARD) 12 April 1996

The *USIS TARD* document provides a comprehensive listing of the USIS requirements for the USIS enterprise and for each of the digital elements, as identified in the *USIS AD&E.*. These requirements both form the basis for Joint Requirements Documents (JRDs) driving USIS implementation and system definition and support the selection of applicable standards. The requirements within this document are applicable to all organizations responsible for the definition, design, development, implementation, operation, and management of the USIS.

3.1.8. Common Imagery Interoperability Facilities Reference Model, V1.0, 8 May 1996

The *CIIF RM* specifies a framework for developing an open application program interface (API) between architectural elements of the USIS that will serve both as a technical specification for the eventual development of the individual API definitions, and as a management tool for planning and controlling the work required to develop these facilities. The interface and facility requirements documented within address objective needs of the USIS. The interfaces themselves, based on an object-oriented, distributed computing model similar in concept to the commercial Object Management Group (OMG) Object Management Architecture (OMA), represent device and location independent software-to-software transactions. This document identifies interfaces that address related API functions, and groups them into interface architecture building blocks called “facilities.”

3.1.9. Video Image Quality Standards and Guidelines (TBD)

This VIQCB document is currently in work. It will address those standards and guidelines necessary to ensure certain levels of video image quality.

3.2. Information Sources

3.2.1. Conops

- Common Imagery Ground/Surface System (CIGSS) Preliminary Motion Imagery Concept, NEL, Jan 1996

- Douglas Forest (Booz·Allen & Hamilton) writings

3.2.2. Requirements

- "Detailed discussion of how imagery products could be inserted into GCCS" brief, author and date unknown
- Preliminary "Motion Imagery Program Products Assessment Project" brief, Dave Jenkins (NEL), 1 April 1996
- “Hunter UAV Data Link" brief, Spencer Cleveland (SDI/JTC-SIL), 1 April 1996
- Pete Wiedemann VWG discussions on Predator UAV
- Draft "MIG Phase II: Video and Imagery Enhancements for GCCS" brief, Mark Kuzma (NISE-EAST), 4 March 1996
- Telephone conversation on “Operational Requirements Document for the Joint Deployable Intelligence Support System (JDISS),” via Dave Bishop (BTG), document date 1 August 1994
- DARO UAV WWW page, http://www.acq.osd.mil/daro/uav, author and date unknown

3.2.3. Standards Information

- SMPTE EGs, RPs, and standards descriptions are excerpted from http://www.smpte.org
- Tape format information (except the SMPTE standards lists) from Appendix 2 is summarized from the Quantel Digital Fact Book, located at http://www.quantel.com/dfb

3.2.4. Technical Content

- “System Concept for End to End Digital Video for Intelligence Systems” brief, Stephen Long (TASC), July 1996
- “Core Video Metadata Proposal,” VWG VMG, September 1996
- “Proposed CIIF Reference Model Modifications to Support Video” brief, Douglas Forest (Booz·Allen & Hamilton), 5 September 1996
- “Preliminary (R0) Metadata Trace for Unexploited and Exploited Video” brief, Ray Harrington, 17 May 1996
- various VWG briefs and writings by Douglas Forest (Booz·Allen & Hamilton)
- A Technical Introduction to Digital Video, Charles Poynton, 1996.

4. BACKGROUND

This section addresses key information that sets the context for the document. This section should be read to understand how video fits into the USIS.

4.1. Assumptions

Video imagery is a relatively new type of intelligence data, and as such is considerably less mature than still imagery. Thus, almost all aspects of video must be addressed simultaneously. However, there are many applicable lessons learned from still imagery systems to ease this process.

The definition of USIS video is restricted to intelligence-related video, generally requiring relatively high resolution sensors; this excludes videoteleconferencing (VTC) equipment and still image framing sensors (with multiple sequential images). VTC is considered an infrastructural capability and as such is not considered part of the USIS video delta.

Because video imagery is essentially just another type of imagery data, the substantial imagery infrastructure can be leveraged for video. Many functions and standards that support still imagery also support video. For example, the data dictionary and cataloging mechanism as a whole support multiple data types.

4.2. USIS

This section describes the USIS, the architecture into which video imagery will be integrated.

4.2.1. USIS Evolutionary Goals

The USIS Architecture Definition and Evolution (AD&E) document describes the full vision of the USIS Architecture, one component of which is to handle video data. The fundamental goal of the future USIS is to "Provide the right imagery data to the right users in the right format at the right time." Specifically,

> In the objective period, the USIS operates as an enterprise,... a group of systems, organizations, and sites operating as a single coordinated entity... As an enterprise, the USIS accommodates complete data, service, and resource sharing. The flexibility of the USIS enterprise provides for changing methodologies and procedures, efficient management of operations, and development and employment of new technologies. To effectively support the enterprise principles, the objective USIS is composed primarily, if not exclusively, of digital systems.

4.2.2. USIS Elements

The USIS Architecture comprises both digital and non-digital elements; however, because the objective architecture is completely digital, only the digital elements are described below (excerpted from the USIS AD&E). Figure 1 illustrates the elements' physical,

communications-oriented connectivity. Note that all elements share a common infrastructure, eliminating stovepipes between elements, hence between applications.

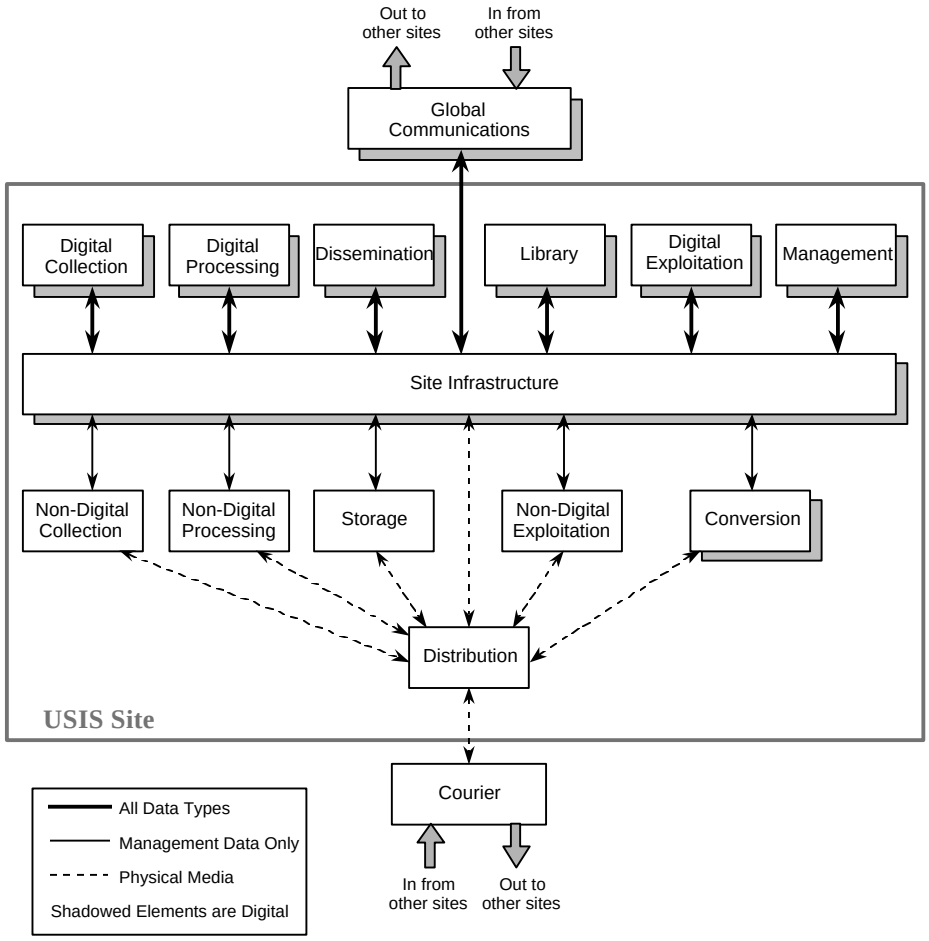


Figure 1. Communication Interfaces Connectivity Between Elements

Figure 2 illustrates the logical or functional application-oriented interfaces between the elements; note that the Management Element is not shown, but has control and status interfaces with the other elements. The objective USIS (long-term) Management Element will interface directly with the other USIS elements. Note that the management of the overall system does not necessarily need to be centralized.

4.2.2.1. Management Element

The Management Element is hierarchically distributed throughout the USIS. It integrates the system process management at an enterprise level. The Management Element allocates resources, controls data flow, and manages the storage and retrieval of information across the USIS.

4.2.2.2. Digital Collection Element

The Collection Element acquires digital imagery in response to assigned imagery collection requirements. The element includes the collector (sensor, platforms, etc.), the ground systems associated with receiving the unprocessed imagery data and collector support

data, and any communications equipment linking the collector and its associated ground systems.

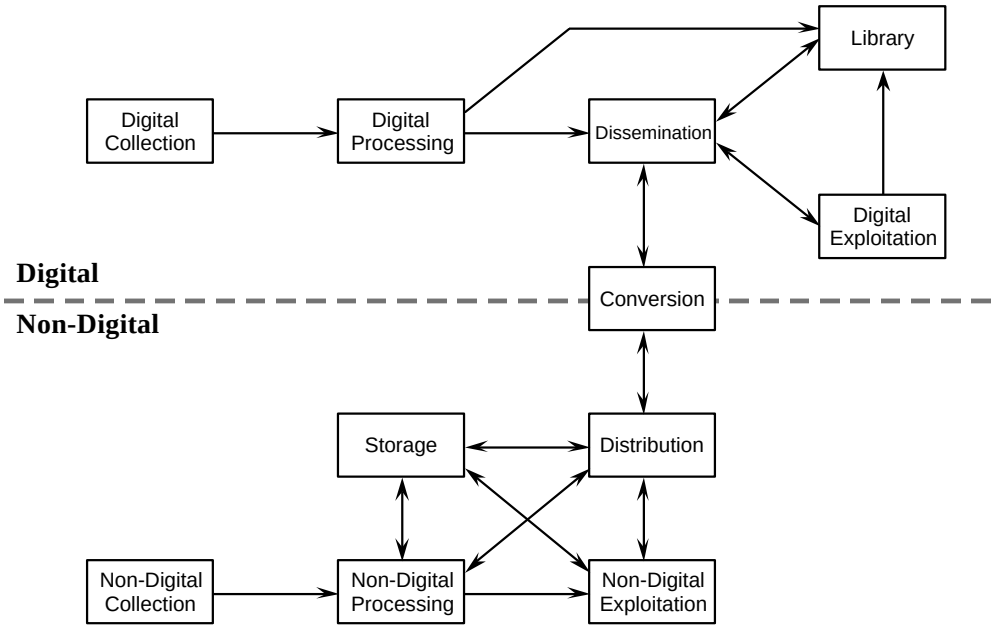


Figure 2. Applications Interfaces Connectivity Between Elements

4.2.2.3. Digital Processing Element

The Processing Element provides the digital processing necessary to reconstruct collected data into image pixels, perform image enhancement, remove detected anomalies, and provide digital imagery in a format appropriate for subsequent disposition.

4.2.2.4. Dissemination Element

The Dissemination Element manages the flow of imagery and product information between the other elements. This element provides addressing services and maintains prioritized queues to control the flow of information among USIS elements.

4.2.2.5. Library Element

The Library Element provides digital storage of imagery and related data, maintains the catalog of that data, responds to queries of its contents, and retrieves the data upon request.

4.2.2.6. Digital Exploitation Element

The Exploitation Element provides tools to manipulate imagery, analyze its content, extract information, and create appropriate products to record the extracted information.

4.2.2.7. Site Infrastructure Element

The Site Infrastructure Element provides generalized computing, storage, and local communications support to other elements. It provides the communications and transfer mechanisms supporting the exchange of information between the elements within a site.

4.2.2.8. Global Communications Element

The Global Communications Element (GCE) provides for the electronic transmission of digital imagery and related data between elements at different sites. A site accessing the G CE can exchange data with any other site connected to the GCE.

4.3. The Video Delta

USIS accommodates generic Digital Imagery data, which includes electro-optical (EO)—visible (VIS) and infrared (IR), synthetic aperture radar (SAR), multispectral imagery (MSI), and video imagery types. Many infrastructural and management areas of the architecture were defined to accommodate any data type—USIS strives to assemble common functions as much as possible, reserving data-dependency only for areas that require additional, or "delta," capabilities or possess unique properties over and above the generic capabilities. Figure 3 illustrates the general concept of video as a subset of other data types.

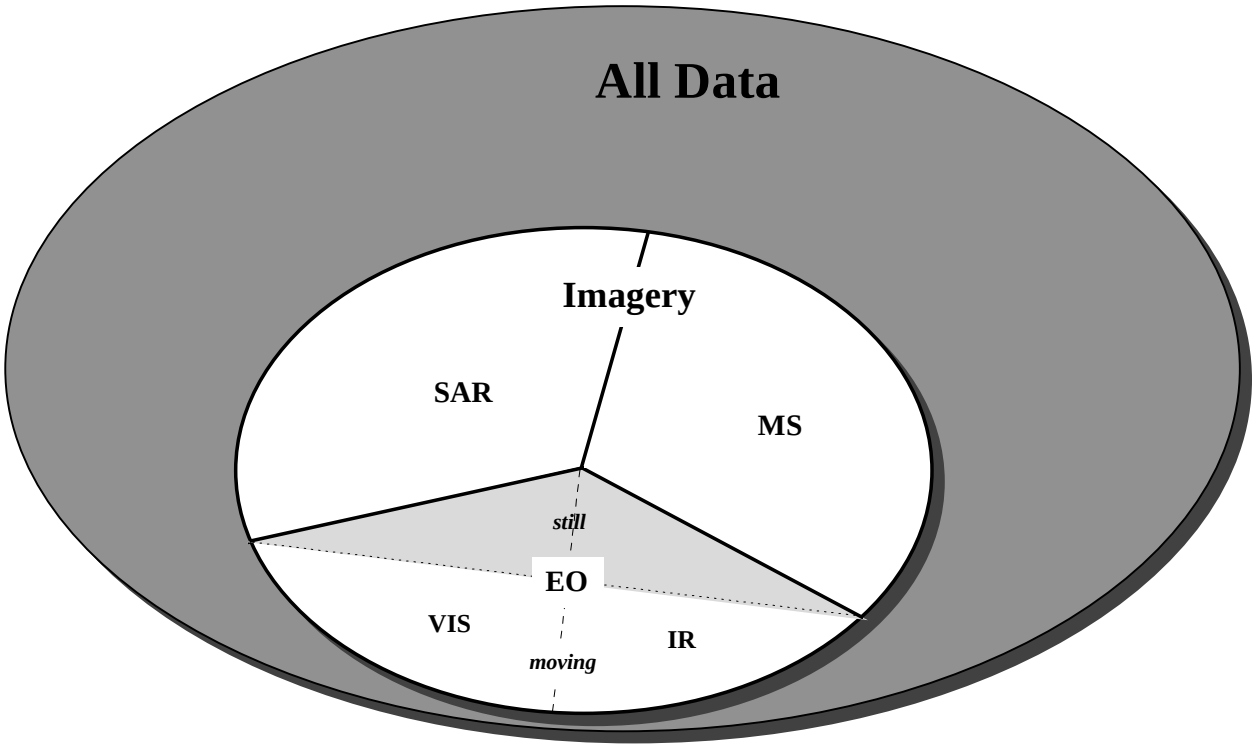


Figure 3. Video as a Subset of Data Types

The "video delta" is that set of specialized functions (embodied in applications or even hardware) not generally used by other data types. Figure 4 illustrates a notional view of the video delta. At the bottom tier is the basic computing and communications infrastructure (e.g., operating systems, disk drives, LANs) common to all types of applications, such as word

processors and WWW browsers. The next tier includes imagery-specific applications, developed to specifically deal with pixels, such as image enhancement or mensuration tools. The next level of distinction is the imagery type (EO, MSI, or SAR), followed by differences within an imagery type (VIS or IR). Finally, at the top tier are applications that deal explicitly with different types of imagery data, such as video decompressors or motion extraction tools unique to video.

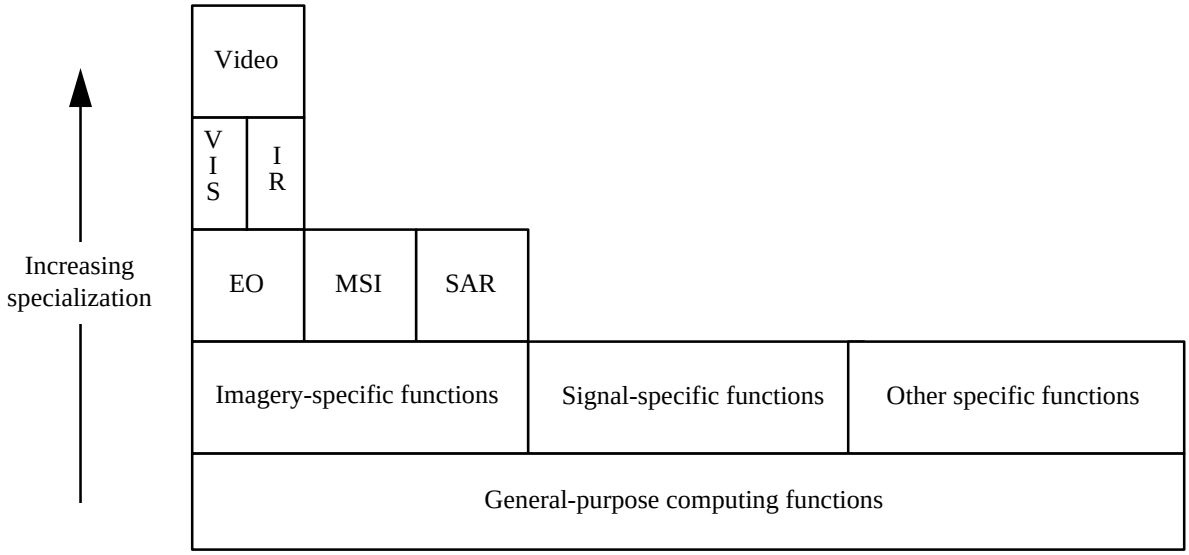


Figure 4. The Video Delta

An example of a common function is the catalog that enables users to identify and locate imagery and imagery-related products in image libraries. This catalog function is not specific to video—any type of data can be retrieved using the same query interface. Although there may be some specific video-unique metadata elements (catalog keywords), the actual catalog framework is data-independent, so video does not require its own catalog. Thus, catalogs are not addressed further in this technical report, although the metadata required to support video will be addressed.

Primary Data Type	Spatial Dimensions	Examples
Visual	x, y, B	Raster & vector images or maps (NITF, VPF, SDTS); imagery
Motion Visual	x, y, t, B	Analog video (NPIC brief, UAV); digital video (UAV)
Volume	x, y, z, B	Raster & vector engineering models (S&T analysis); 3D reconstructions (medical, IPT); DTED; DFAD
Motion Volume	x, y, z, t, B	Battlespace reconstructions
Waveform	x, t, B	Telemetry; audio
Text	None	Text reports; cables; e-mail
Other	None	DB records, support data

where x, y, z represent spatial dimensions; t = time; B = spectral band

Figure 5. Dimensions and Data Types

Another view of the video delta concept is illustrated in Figure 5, which depicts the dimensional dependency of data type definitions. Note that in many cases, eliminating one dimension yields another data type. For example, video is a time varying sequence of still frames. This is illustrated another way in Figure 6, where the different dimensions of data types overlap to produce related data types.

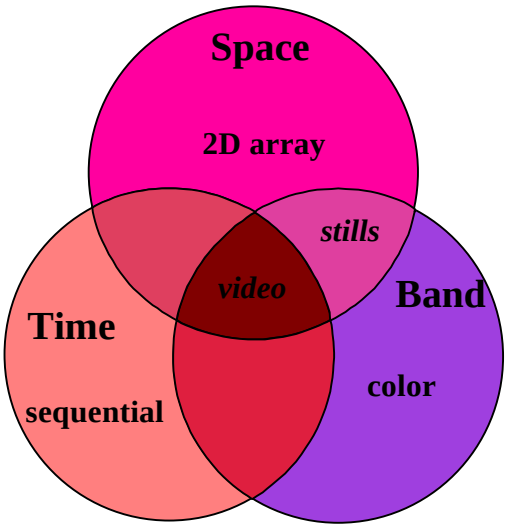


Figure 6. Example of Data Type Overlap

4.4. Video Quality

The aesthetic quality of a video product tends to be one of the higher-ranking and most noticeable concerns among users; however, aesthetic quality does not necessarily dictate information content. Although the quality of the sensor and the imaging conditions are important factors, once the video is collected, it is vulnerable to further degradation at many points throughout the system.

Aside from the imaging environment and conditions, which factor into the mission plan, the video system can be engineered starting with the sensor (continuing through the sensor mount to the platform itself, etc.). The initial video signal quality is a function of spatial range, including factors such as pixel array density, and resolution, and dynamic range, including factors like pixel precision, or depth. From the sensor, the output signal can either be component or composite. The highest quality cameras provide full-resolution component signals, with separate luma (brightness) and two chroma (color) signals. By maintaining these signals separately, the maximum quality is attained. When these signals are combined to form a single composite signal, irreversible distortion and artifacts such as red/blue edge blurring and chroma/luma crossover are introduced; this can complicate editing and image enhancement. The extent of the effect on interpretability has not yet been quantified.

Converting the video signal from analog to digital can introduce more distortion, and since not all converters perform the same, the results will vary between systems. In addition, spatially subsampling the video image degrades quality: studio-quality video signals are often decimated to one-quarter of the original resolution upon transfer to common videotapes. The issue of resolution decimation to reduce storage requirements requires further study.

Communications capacity is another critical parameter for real-time or stream playback video. If the capacity is insufficient to support the required bit rate, the video quality will suffer because more video data will be discarded by the compressor to keep the throughput down.

Even the cables used to transport the video can impact video quality. Although analog video data tends to degrade over longer cable lengths, digital video data drops off completely beyond a certain distance.

Finally, the viewing monitor and viewing conditions can affect the visual quality of the product, although it does not distort the original data. When viewing digital video data, a digital monitor will minimize distortion due to D/A conversion.

5. VIDEO IMAGERY CONCEPT OF OPERATIONS (CONOPS) AND REQUIREMENTS AND STANDARDS IMPLICATIONS

In order to properly define and orient requirements, it is necessary to have a concept of system operation. The conops below is intended to describe this operation at a high level. There are many possible conops, so more detailed operational descriptions may be required. Each conops paragraph is accompanied by a characterization of the corresponding requirements and standards implications. Note that not all of the capabilities described are available today.

Conops Text	Requirements and Standards Implications
Video imagery[1] can provide a wide range of derivative products to diverse users with multiple needs. The temporal (time-based) aspect of video captures details unavailable in still imagery, such as relationships between subjects, activities, target tracking, and motion speed/direction determination.	*New products need to be defined, as well as new exploitation tools and methods to accommodate the temporal dimension of video. Video-unique formats and operations need to be standardized or adopted.*
Potential video applications include: operational users receiving real-time video for "over-the-hill" lookahead, surveillance, and target tracking; operational intelligence users monitoring near-real-time video for bomb damage assessment (BDA) and reconnaissance; strategic intelligence users exploiting video after it is collected to perform precision mensuration, and target speed/direction determination; and "public relations" users disseminating collected video for news reports and related activities.	*Users, developers, and researchers need to devise new or improved uses for video—the still imagery paradigm needs to be changed. Possible uses range from the conventional (supplying footage for briefings, TV media, etc.) to cutting edge (3D model rendering from video).*
Video products will include full-motion video; video clips; temporally-subsampled video, where every n^{th} frame is sent; still mosaics, collections of several frames to assemble a larger picture; still frames; audio annotations, provided while the video is being collected; and voice reports, provided after reviewing the video data. Metadata can also be provided to users, although it is actually information about the video data and not a separate product per se. Video data will be combined with textual annotations, line graphic overlays, still images (including EO, IR, SAR, and MSI), maps, and signals to provide finished products.	*Again, video will spawn a wide range of derived products, as well as become integrated with other product types. The tools to generate these products will need to be developed or modified, and will require greater computing resources due to the intrinsic volume of video data. Metadata must be standardized to allow free interchange. Common methods of registration, overlaying, and rendering need to be established to allow seamless mixing and fusing of*

[1] Only intelligence-related video are intended; this includes television broadcasts, such as those collected by the Foreign Broadcast Information Service (FBIS) but excludes videoteleconferencing (VTC).

Conops Text	Requirements and Standards Implications
	different product types.
Both still and video imagery are dependent upon the equipment chain from sensor to user; sensor resolution, compression concatenation, and display characteristics all impact the perceived quality at the users' end. Full-motion video has an additional dependency on the communications capacity; insufficient capacity will degrade the video quality as well.	*The sensitivity of video quality on the end-to-end system will require an augmented infrastructure. This will not be inexpensive, but unfortunately video is resource-intensive data. Standards will be critical to defining common interfaces, formats, and operations to ensure interoperability.*
All video components will be standards-based commercial-off-the-shelf (COTS) as much as possible to reduce costs. Interoperability will be established via standards and guidelines. For example, MPEG-2 will be used to provide video compression and video, audio, and metadata transport. Commercial standardized interfaces will be adopted whenever possible, with government-standardized interfaces used only for unique functions.	*The key to ensuring affordability and interoperability is to leverage the billions spent by commercial industry on video research, development, and products. Fully custom solutions will not be viable. Standards-based solutions are required for system interoperability and modularity. Backwards compatibility and system migration will need to be addressed.*
There will be several different video sources, including national, tactical, commercial, and foreign assets; gun cameras; broadcasts; and surveillance/ monitoring cameras. EO video sensors, comprising visible and IR, will provide both monoscopic and stereoscopic collection.	*As the number of different types of video sources grows, so will the need for collection, processing, and exploitation capabilities, some of which will have unique needs.*
Diverse video platforms, either on the ground, airborne, spaceborne, or undersea, will provide unique collection perspectives. The platforms will be able to both sustain extended missions to maximize coverage and dwell to maximize video quality via sensor stability. Both the platform and the sensor will be controlled either by a mission control element or by a remote user. Coverage will be available during all seasons and weather conditions, day or night.	*An increased number of different platforms makes the need for common data even more critical. The amount of data collected will no doubt require more humans to interpret, or more strongly drive the need for automated tools. All-weather video systems will eventually be needed.*
Video assets will be managed primarily to maximize real-time operational responsiveness (for dedicated unit-level support) via resource sharing. A secondary goal is to reduce redundant collections. Video tasking will support all organization sizes, from individuals to exploitation centers, and users will be prioritized to ensure that the shared assets	*This will impact not only the quantity of data collected, but the management of all these assets will become difficult. Non-traditional management systems will be needed to maximally leverage the infinite flexibility of these diverse platforms.*

Conops Text	Requirements and Standards Implications
are maximized. Scheduling timelines range from hours (e.g., UAVs) to days (e.g., hand-held assets); however, dynamic retasking will be accommodated to ensure coverage of targets of interest; this may be facilitated through remote operation. System maintenance and upgrades will not impact coverage.	*Standardized command and control methods will be needed to provide this level of flexibility.*
Video will be disseminated in response to specific taskings or standing profiles (i.e., requests), with a timeliness ranging from full-motion live video to full-motion playback during dissemination to playback after the full file is received. Metadata will be associated with video data both as the data is collected and after the video data is exploited; the metadata will include non-textual items like mosaics and icons. A global catalog based on standardized metadata will enable still imagery and video imagery to be located and retrieved in a similar manner.	*The dissemination method will dictate the communications capacity and quality of service needs. Video-specific metadata will also need to be defined to account for its differences from other imagery types. However, using standardized metadata will allow the catalog mechanism, for example, to remain substantially the same.*
Platform-scalable video manipulation tools will provide enhancement, such as motion compensation; geopositioning; mensuration; surveillance and tracking, including change detection and target counting; multi-source data fusion; image perspective transform (IPT); 3D-modeling and extractions; and engineering studies and calibrations. Many of these tools will provide collaborative capability and near-realtime support.	*Video-specific product generation will require new and more powerful and resource-intensive tools. COTS tools will be built to recognize primarily standardized formats, and collaboration certainly requires interoperability.*
Video data will be stored hierarchically, including online and offline, and will be available either locally (private data) or globally (public data). Because some video data can be perishable, particularly in the operational environment, it will be retained for variable lengths of time, ranging from a few hours, supporting surveillance and anomaly resolution, to permanently, supporting trending and change analysis. Because video data is voluminous, some of the data may not be retained.	*This is a resource issue, but must be solved via both technology and policy. Much larger servers and alternative storage methods will be required. A new concept of operations will be required because it is currently nearly impossible to keep all the data collected, and this must be a consistent, or at least clearly stated, policy across the board.*
The existing information infrastructure will be leveraged as much as possible to support video data, with provisions for video's special needs. Some video characteristics that may require special accommodation include increased storage and	*Video does not require its own infrastructure, but does require a robust, capacious one, again raising the issue of cost. Standards-based systems will allow for modular*

Conops Text	Requirements and Standards Implications
communications capacity and isochronous communications connections. Both ordinary television sets and computer monitors will be used to display video data. Types and strength of video security will need to be determined; possible solutions include encryption, integrity seals, and data guards.	*expansion, avoiding complete infrastructure replacement. In terms of security, new methods to protect video will need to be developed or evaluated.*

6. PROPOSED VIDEO DELTA TECHNICAL REQUIREMENTS

As described above, only the video-specific "delta" technical requirements are addressed in this section; they are organized by USIS element. These draft requirements are currently based on extractions/translations from system capability briefs and engineering judgement. Because the objective USIS will be all digital, this document emphasizes digital requirements. Analog systems are considered migration and are addressed in the appendices. In addition, the services and video-related requirements from the most recent USIS TARD (as specified in Section 2) are listed in Section 14.

6.1. Management Element

There are currently no proposed new requirements for the Management Element, because the Management Element only manages data and does not actually touch it. Most significantly, video products will be cataloged the same as still imagery, with the USIS SPIA defining the library query parameters. The only change in this case is to update the SPIA to accommodate video, but this is not a requirements-based change; the VWG's Video Metadata Group (VMG) is addressing common video-related ESD to be added to SPIA. The existing Management Element services are listed in Table 9 in Section 14; there are no proposed video delta management requirements.

6.2. Collection Element

The current USIS TARD already accommodates digital collection, including handheld and airborne digital video collection, as listed in Table 10 in Section 14. Proposed additions are listed in Table 2 below.

Table 2. Proposed Collection Element Video Delta Requirements

Collect video from national sources
Collect video from foreign sources
Collect video from commercial sources
Collect video from other sources (such as law enforcement)

6.3. Processing Element

Digital video processing already adequately accommodated in the USIS TARD, as listed in Table 11 in Section 14. However, provision needs to be made for converting analog video to digital. Metadata will need to be generated from support data for all types of data, including video. Refer to Table 3 for proposed additions.

Table 3. Proposed Processing Element Video Delta Requirements

Digitize analog video
Compute metadata from support data

6.4. Dissemination Element

Most dissemination functions will support video, as listed in Table 12 in Section 14. There are no proposed video delta dissemination requirements.

6.5. Library Element

The only major difference for video is to define capacities for the libraries. The data access and management mechanisms are similar to those for still imagery and can be expanded to accommodate video. Refer to Table 13 in Section 14 for the TARD Library requirements; proposed additions are listed in Table 4 below.

Table 4. Proposed Library Element Video Delta Requirements

Store video data in libraries
(TBD) hours in IPL
(TBD) hours in CIL
(TBD) hours in NIL
Retain video data for variable length depending on usage
Operational data
(TBD) days in IPL
(TBD) days in CIL
(TBD) days in NIL
Historical data
(TBD) months in IPL
(TBD) months in CIL
(TBD) months in NIL

6.6. Exploitation Element

Video exploitation is not explicitly discussed in the TARD, as seen in Table 14 in Section 14; video should be specified under each current Exploitation Element requirement because in some cases it poses a significant change. Analog video will be digitized before exploitation. Proposed additions appear in Table 5 below.

Table 5. Proposed Exploitation Element Video Delta Requirements

Provide digital video analysis/exploitation tools
Provide zoom capability.
Provide scroll capability
Provide non-linear brightness adjustment.
Provide non-linear contrast adjustment.
Provide color balance adjustment
Measure color coordinates.
Provide three-dimensional modelling
Provide event understanding (interpret objects and motion)

Provide motion detection
Provide tracking of moving objects
Direction
Velocity
Compute/depict images with maps, charts, and targets
Provide the ability to display and mensurate Digital Point Position Database (DPPDB) data
Monoscopic
Stereoscopic
Provide video registration (to a set of geographic coordinates) capabilities.
Overlay registered video data onto maps.
Overlay threat data on video data.
Provide multimedia annotation capability on video, clips, or still images.
Provide text annotations.
Provide graphic annotations.
Provide vector-based annotations (e.g., FOV center coordinates, target location, North arrow, reticle overlays, black/white hot overlays)
Provide raster-based annotations.
Provide audio annotations.
Provide voice annotations.
Provide sound annotations.
Provide mensuration capability.
Derive geographic coordinates from video and support data.
Derive positioning information from video and support data.
Measure size of objects in video data.
Measure length of objects in video data.
Measure height of objects in video data.
Measure velocity of objects in scene.
Measure acceleration of objects in scene.
Derive geographic coordinates from imagery using the RPC capability.
Generate video-derived products
Full-motion video products
Video clip products
Still video mosaic products
Still frame imagery products
Metadata and support data products
Voice-annotated report products
Text message report products
Hardcopy products
Provide capability for video product preparation

6.7. Site Infrastructure Element

Video will leverage the existing Site Infrastructure as much as possible; refer to Table 15 in Section 14. Proposed updates appear in Table 6.

Table 6. Proposed Site Infrastructure Video Delta Requirements

Display full motion (30 frames/second) video.
Display analog video.
Display digital video.
Provide high resolution displays.
Interlaced.
Progressive scan.
Provide VCR-like video controls
stop
play
record
forward
fast forward
rewind
fast rewind
pause
Provide basic video analysis tools.
Provide zoom capability.
Provide scroll capability.
Provide brightness adjustment.
Provide contrast adjustment.
Provide geoposition derivation from video data.
Provide video briefing system output capabilities.
Provide capability to transfer video via different methods
Computer networks
Television broadcast
Provide capability to capture still frames.
Provide capability to capture digital video clips.
Provide buffer capability.
Provide (TBD) GB of fast on-line storage.
Provide fast on-line memory.
Provide capability to write to tape (e.g., 8 mm).
Provide analog to digital (A/D) conversion.
Provide digital to analog (D/A) conversion.
Provide video format conversion capability.
Support video compression.
Compress video data to a selectable visual quality.
Compress video data to a selectable numeric quality.
Compress video data to a selectable file size.
Compress video data at a selectable bit rate.
Expand compressed video data to support full motion (30 frames/second) video display.

6.8. Global Communications Element

The Global Communications Element is data independent, with the exception of data type-dictated quality of service (QoS) and timing requirements; video data requires isochronous timing for real time transfer, while pure file transfers have no special timing requirements. Note that good quality MPEG-2 video broadcast typically requires at least 3-6 Mb/s; the minimum data rate accepted by industry is 3.6 Mb/s. This data rate will not be required of all users due to limited availability, especially for tactical users. Refer to Table 16 in Section 14 for excerpted TARD information. Proposed updates appear in Table 7.

Table 7. Proposed Global Communications Element Video Delta Requirements

Support real-time multimedia data transport over data networks.
Provide isochronous data transport.
Support “television-style” video broadcast

7. STANDARDS IMPLICATIONS AND STANDARDS UNDER CONSIDERATION

This section discusses areas in need of standardization and standards that have been identified as candidates for USIS adoption. The VWG is currently researching these standards.

The Society of Motion Picture and Television Engineers (SMPTE) produces engineering guidelines (EGs), recommended practices (RPs), and standards to promote interoperability within the broadcast television industry, many of which will solve some of our interoperability needs.

7.1. Digital Video Scanning Standards

Video scanning standards specify the method by which video data are displayed. For analog televisions, there are many different scanning and color standards. In the US, the 525 line/59.94 Hz system is used with NTSC color encoding. Other countries use different methods, such as 625 line/50 Hz and PAL or SECAM color.

Since the FCC has recently accepted a US HDTV standard, additional scanning formats may need to be considered.

7.1.1. Recommendation ITU-R BT.656-3 - (REVISED) Interfaces for digital component video signals in 525-line and 625-line television systems operating at the 4:2:2 level of Recommendation ITU-R BT.601 (Part A)

This standard describes the encoding of the CCIR 601 digital signal.

7.1.2. SMPTE 274M-1995 - 1920 x 1080 Scanning and Interface

This standard specifies raster scanning formats for constant frame rate video with a resolution of 1920 x 1080 pixels and an aspect ratio of 16:9 (i.e., HDTV). It specifies RGB, YPbPr, $Y'C'_bC'_r$, and $Y'C'_bC'_rA$ (A is an auxiliary component) encoding.

7.1.3. SMPTE 293M - 720 x 483 Active Line at 59.94-Hz Progressive Scan Production - Digital Representation

This standard specifies the digital representation for constant frame rate video with a resolution of 720 x 483 pixels and an aspect ratio of 16:9. It is primarily used for NTSC letterbox encoding. It specifies R'G'B' and $Y'C'_bC'_r$ encoding.

7.1.4. SMPTE 296M (Proposed) - 1280 x 720 Scanning, Analog and Digital Representation and Analog Interface

This standard specifies raster scanning formats for constant frame rate video with a resolution of 1280 x 720 pixels and an aspect ratio of 16:9. It specifies R'G'B', $Y'P'_bP'_r$, and $Y'C'_bC'_r$ encoding.

7.1.5. CCIR Rep. 624-4

This standard specifies all parameters of analog TV (NTSC), including the number of active lines.

7.2. Video Time Code

The SMPTE video time code, specified in SMPTE 12M, can be implemented in various ways to provide greater functionality.

7.2.1. RP 159-1995 - Vertical Interval Time Code and Longitudinal Time Code Relationship

This RP specifies the relationship between vertical interval time code (VITC) and longitudinal time code (LTC) on tape.

7.2.2. RP 164-1992 - Location of Vertical Interval Time Code

This RP defines the preferred location of the vertical interval time code (VITC) at equipment interfaces and on tape.

7.2.3. RP 169-1995 - Auxiliary Time Address Data in Binary Groups

This RP specifies an auxiliary time address coding method into the binary groups of SMPTE time and control codes. This provides another time address storage and storage location.

7.2.4. RP 188-1996 - Transmission of Time Code and Control Code in the Ancillary Data Space of a Digital Television Data Stream

This RP defines a transmission format for LTC or VITC data formatted according to SMPTE 12M in 8- or 10-bit digital television data interfaces. The ancillary data space is as defined in SMPTE 291M.

7.2.5. SMPTE 266M-1994 - 4:2:2 Digital Component Systems - Digital Vertical Interval Time Code

This standard describes the signal format of a digital VITC to be used SMPTE 125M signals (for 525/59.94 4:2:2 component digital signals).

7.3. Video Compression

MPEG-2 was approved as the official USIS video compression technique by the ISMC on 27 June 1996. MPEG-2 is superior to competing algorithms for many reasons: it is an international standard, widely supported by commercial industry, it supports high quality formats, provides good compression ratios, and is backwards-compatible with MPEG-1.

In contrast, none of the competing algorithms have comparable technical capabilities or economies of scale. Motion-JPEG compresses each frame as a separate still image, which does not leverage the temporal redundancy inherent in video, limiting its compression performance; it is also not standardized, which creates cross-vendor interoperability problems.

MPEG-1 was designed for limited bit rate applications, such as the 1.5 Mb/s data transfer rate of CD-ROM players. To accomplish this enormous reduction, the spatial resolution is decimated by 50% in both horizontal and vertical resolution—a 75% reduction in data before compression with approximately 0.34 NIIRS quality loss.

Other standards include MPEG-4, which is still in development; ITU H.261, which is intended for videoteleconferencing applications; and ITU H.320, which is comparable to MPEG-2, but does not enjoy the same commercial support.

7.4. Video File Formats

Although MPEG-2 specifies a file format, there may be other file formats warranting further research.

7.4.1. SMPTE 268M-1994 File Format for Digital Moving-Picture Exchange (DPX)

This standard specifies a file format for digital video data exchange between computer-based systems.

7.5. Video Ancillary Data

SMPTE 259M provides for the transport of ancillary data along with the video signal. The following standard provides guidance on its use.

7.5.1. SMPTE 291M-1996 - Ancillary Data Packet and Space Formatting

This standard specifies the basic formatting structure of the 10-bit ancillary data space in the digital video steam. Locations available for ancillary data packets are defined in the connection interface specification.

7.6. Video Index Data

These standards may provide either insight or a partial solution to the video indexing problem.

7.6.1. RP 186-1995 - Video Index Information Coding for 525- and 625-Line Television Systems

This RP provides a method of coding a video index information data structure into component digital video signals so that related source data can be transported with the video signal. The actual data structure transport is specified in SMPTE 125M and SMPTE 267M (these are both parallel interfaces, in contrast to the serial 259M, so this may not be applicable).

7.6.2. SMPTE 262M-1995 - Binary Groups of Time and Control Codes - Storage and Transmission of Data

SMPTE 262M defines a directory index for different types of data carried in the SMPTE time code (VITC and LTC) user bits. The index occupies two time code binary groups.

7.7. Video Data Universal Labelling

7.7.1. SMPTE 298M (Proposed) - Universal Labels for Unique Identification of Digital Data

This standard defines universal labels, used to identify data type and encoding in a general-purpose data stream, that are attached to and are transmitted with the data. The labels support all types of communications protocols and message structures, providing unique and organization-traceable labels.

7.8. Video Signal Interfaces

7.8.1. SMPTE 125M-1995 - Component Video Signal 4:2:2 - Bit-Parallel Digital Interface

This standard defines a parallel interface for studio CCIR 601 video equipment over a maximum distance of 300 meters.

7.8.2. SMPTE 259M-1993: 10-Bit 4:2:2 Component and $4f_{sc}$ NTSC Composite Digital Signals - Serial Digital Interface

SMPTE 259M specifies a serial digital interface for 525/59.94 digital television equipment operating with 4:2:2 component signals; the $4f_{sc}$ NTSC composite digital signals will not be used in USIS. It is the industry standard for transporting studio-quality CCIR 601 video.

SMPTE 259M is recommended as the universal "common" digital video interchange medium to provide the universal hardware interface, while 4:2:2 10 bit CCIR 601 component digital video provides the universal video signal interface.

As illustrated in Figure 7 below, all intermediate processing steps can preserve quality and not degrade it further by immediately converting it to the highest level possible, performing any desired processing operations, and then only after all processing is done, converting it back down to the required format. This will not improve poor quality video but, at the very least, will not further degrade it in the interim.

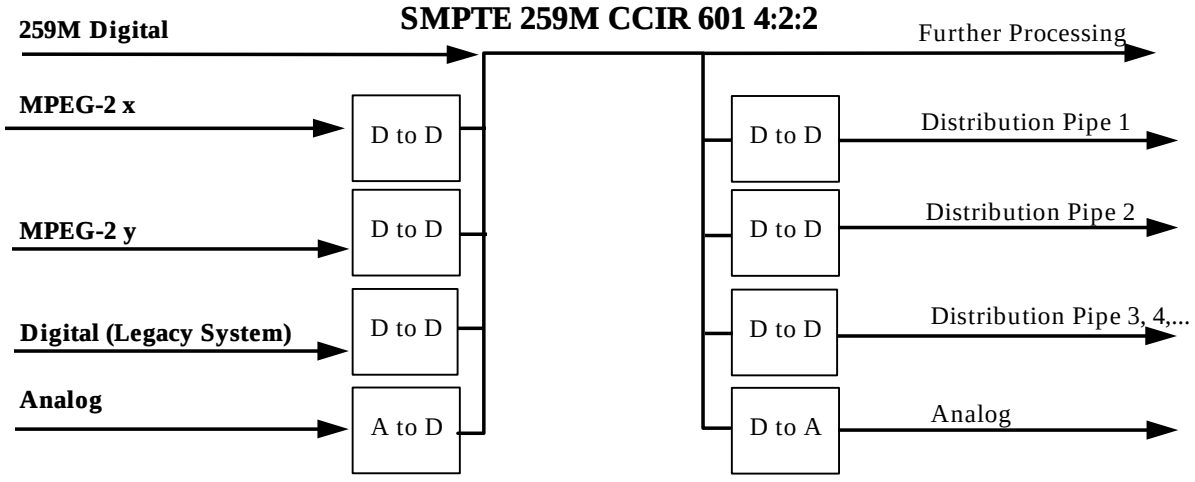


Figure 7. Use of SMPTE 259M and CCIR 601 4:2:2 to Ensure Quality

7.8.3. SMPTE 267M-1995 - Bit-Parallel Digital Interface - Component Video Signal 4:2:2 16x9 Aspect Ratio

This standard defines a parallel interface for 16x9 aspect ratio studio CCIR 601 video equipment over a maximum distance of 300 meters.

7.8.4. SMPTE 294M - 720 x 483 Active Line at 59.94-Hz Progressive Scan Production - Bit-Serial Interfaces

This standard defines two serial interfaces for 720 x 483/59.94-Hz progressive scan digital signals defined in SMPTE 293M. These interfaces are interoperable with SMPTE 259M.

7.8.5. SMPTE 292M - Bit-Serial Digital Interface for High-Definition Television Systems

This standard defines a serial interface for HDTV component signals. Both digital coaxial and fiber optic interfaces are supported.

7.8.6. SMPTE 297M (Proposed) - Serial Digital Fiber Transmission System for ANSI/SMPTE 259M Signals

This standard defines a serial fiber optic transmission method to support SMPTE 259M, and is compatible with SMPTE 292M (higher rate HDTV interface).

7.9. Common Facilities

7.9.1. USIS Common Imagery Interoperability Facilities (CIIF)

The CIIF RM comprises interfaces and facilities; the interfaces themselves represent device and location independent software-to-software transactions. Interfaces that address related API functions are grouped into interface architecture building blocks called "facilities." Table 8 below lists and describes video-related facilities, grouped by interface type; not all the definitions are complete, as indicated by TBR or TBD. For more details, refer to the CIIF RM document version specified in Section 2.

Table 8. CIIF RM Interfaces and Facilities

Interfaces	Facilities	Facility Description	Video-Related Comments
Information Access Interfaces	Catalog Access Facility	"Supplies a set of common software interfaces to support both local and global imagery product discovery, product attribute (metadata) retrieval, product browsing, and product cataloging and indexing."	Need to operate on both video clips and individual frames Catalog data structure for video is critical and is TBD May need to add specialized operations to accommodate temporal factor

Interfaces	Facilities	Facility Description	Video-Related Comments
	Image Access Facility	"Defines a set of interfaces for retrieving selected imagery products from an imagery library, and for updating the contents of an imagery library (by storing, deleting, or modifying imagery products)."	Need to accommodate different video quality of service (QoS) retrieval options Needs to allow image data access via (x, y, z, t, B) parameters (e.g., space, time, and spectral) Need to accommodate temporal dimension Propose specifying multiple image extraction types (spatial, temporal, spectral)
	Imagery Compression Facility	"Defines a set of interfaces to generalized services for imagery compression and decompression, and for conversion between internal representations and standardized representations of such data."	MPEG-2 selected as standard (this will define the interface) Generalize statements to include video compression
	Imagery Dissemination Facility	"Defines the interfaces required to receive, prepare (i.e., reformat, compress, decompress, etc.), prioritize, and transmit imagery products; also defines standard interfaces to support product distribution management."	IAF will handle lower level details for video-unique playback
	Profile and Notification Facility	"Supplies a set of standard interfaces to support the registration and maintenance of standing interest profiles for imagery consumers; also provides interfaces to support the screening of products against these profiles, and to route products or product availability notifications, as appropriate"	None
	Video Access (TBR)	"Supplies a set of common software interfaces to support both local and global video imagery product discovery, product attribute (metadata) retrieval, product browsing, product cataloging and indexing, product retrieval, and for updating the contents of a library (by storing, deleting, or modifying video products)."	Recommend removal as functions are adequately handled by modifying other facilities.
Exploitation Support Interfaces	Image Mensuration Facility	"Provides standard interfaces to software tools that are designed to measure the spatial characteristics of objects appearing within images."	Need to address temporal mensuration Might utilize the ATR and IU facilities Propose adding temporal mensuration functions (e.g., speed measurement, direction determination)

Interfaces	Facilities	Facility Description	Video-Related Comments
	Image Processing Facility	"Provides interfaces to standard algorithms for manipulating imagery (resizing, changing color and contrast values, applying various filters, manipulating image resolution, etc.) and for conducting mathematical analyses of image characteristics (computing image histograms, convolutions, etc.)."	None
	Image Registration Facility	"Provides standard interfaces for automatically aligning, co registering, or otherwise determining image-to-image spatial correlations on the basis of image content."	Video mosaics need to retain original frame identities and metadata Proposed adding temporal registration
	Geopositioning Facility (TBR)	"Defines standard interfaces to software tools that support the derivation of precise geographic coordinates on images and maps."	Propose adding video frame averaging for improved geopositioning
	Automatic Target Recognition (TBR)	"Provides standard interfaces to software tools that are designed to automatically detect, categorize, count, and determine relationships between objects appearing within images"	Add the following operations: Object motion characterization Moving object behavior characterization Moving object relationship characterization
	Image Synthesis	"Provides a common software interface for creating or transforming images using computer-based spatial models, perspective transformations, and manipulations of image characteristics to improve visibility, sharpen resolution, and/or reduce the effects of cloud cover or haze."	Video data is a good source for modeling, terrain rendering, fly-by, etc. Propose adding video frame averaging for sharpening/smoothing
	Image Understanding	"Enables automated image change detection, registered image differencing, significance-of-difference analysis and display, and area-based and model-based differencing."	Propose adding object tracking and motion extraction
	Video Exploitation (TBR)	"Provide access to automated tools for the exploitation of video imagery."	Recommend removal as functions are adequately handled by modifying other facilities.

7.9.2. OMG Video Request for Proposal (RFP)

The OMG recently released an RFP calling for audio/visual (A/V) stream management. The current OMA handles traditional request/response interactions, which will only support video file transfer. Real-time feeds or server playbacks cannot be handled in this way.

OMG recently released an RFP to address isochronous data transfer (hence, video stream playback). The document is telecom/96-08-01, *Control and Management of A/V Streams Request for Proposal.* This RFP addresses exactly the solution that is needed to support USIS video. Submissions are due 17 February 1997.

7.10. Metadata

A core set of metadata is currently being defined by the VWG Video Metadata Group (VMG) for immediate implementation; the core set contains the minimum metadata required to make video useful (e.g., date, time, position, classification). This minimal set will support existing analog systems (via closed captioning channels) and provide a common thread for migration to digital systems. A second, more inclusive, set will be defined later; it will take advantage of greater digital capacity and the MPEG-2 private data streams to multiplex the metadata and video data.

7.10.1. Metadata Implementation

A set of video units is needed to qualitatively describe video segment types; this will help categorize metadata for various purposes and determine the frequency of data element updates. There are both objective and subjective video units. Objective video units do not require human or computer interpretation and can be used for both exploited and unexploited video; these include:

Frame	The smallest video unit managed for queryable metadata
Sample Frame	A frame sample every 10 (TBR) seconds from sensor
Video Mission	A complete sequence of Frames and Sample Frames associated with the video mission

Subjective video units, on the other hand, requires human or computer interpretation and thus can be used only for exploited video; these include:

Shot	Logical sequence of Frames
Scene	Logical grouping of Shots
Program	Complete sequence of Scenes

7.10.2. Potential Data Encoding Methods

The simplest way to encode metadata is to use fixed slot assignments, with the same set of data elements sent in predefined positions every frame. Unfortunately, this does not provide any reduction in the amount of metadata.

There are several ways to compactly encode metadata within its carrier stream as illustrated in Figure 8 below. One method is sub-commutation, where the data elements are sent alternately in each slot, with predefined positions and order; there may be several different frame structures, but all are repeated in order. Another method is delta encoding, where the initial value is recorded, then subsequent changes from that value—essentially Differential Pulse Coded Modulation (DPCM). Finally, there is tagging, or free-form, with each value associated with its identifier; there are no fixed slot assignments or frame structure. All these methods can be combined and compressed as well.

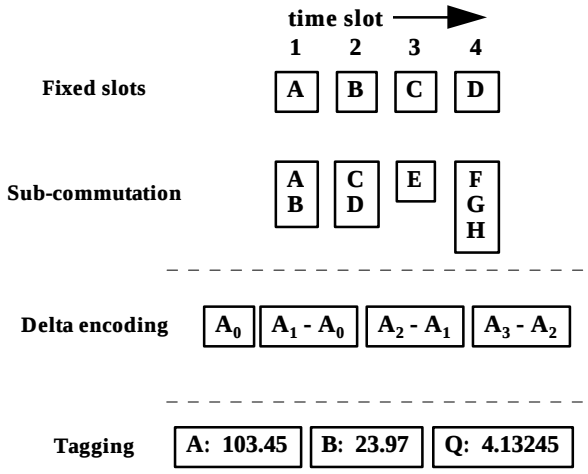


Figure 8. Potential Data Encoding Methods

7.10.3. Commercial solutions

There are several possible metadata transport implementations currently available:

- Audio channels
- Closed caption data channels (CC1 - CC5)
- Parallel data channels (e.g., STU-III, SATCOM)
- MPEG-2 user bytes
- MPEG-2 private data streams

The use of audio channels is not recommended because data protection cannot be guaranteed. CC channels are not protected either, but there are recommended practices governing their use. In addition, not all TVs can decode all five CC lines (CC1 - CC5)—although most new TVs can read them.

The metadata could also be sent completely separately from the video data in a parallel data channel, ensuring that the data remains digital (hence simplifying computer access). However, tracking, handling, and assembling both video and the associated metadata separately may become intractable.

MPEG-2 is the most viable solution, although the marketplace does not yet fully protect the private data or user bytes. The need for users' implementation of the private data streams has been recognized by industry and work is underway to ensure success at the ANSI and ISO standards levels.

8. POTENTIAL GAPS

8.1. Requirements

Video-specific exploitation requirements need to be better defined to ensure that time-measuring operations, such as speed measurement, direction determination, target tracking, video mosaicing, video fusion, motion detection, and motion characterization, are adequately addressed. Some related requirements may be available in existing softcopy exploitation documents.

In addition, required video capacities and volumes are needed for sizing video application and storage implementations.

8.2. Standards

The VWG is researching additional standards to recommend, At the moment, however, the only official selection as approved by the ISMC, is MPEG-2.

A full end-to-end list of relevant video standards is needed to ensure complete coverage for a standards profile that will be added to existing DoD/IC standards profiles.

8.3. Technical Issues

Video archiving and retrieval (via indexing) also need to be addressed in more detail.

9. AFFECTED DOCUMENTS

This section both identifies and describes documents that may be affected by the video information contained in this technical report. The intent of this section is to identify and briefly generalize the potential impacts of video modification due to this document's content. Eventually, these documents will require RFCs to properly accommodate video.

9.1. USIS Architecture Definition and Evolution (AD&E)

The *USIS AD&E* provides a high-level definition of the USIS architectural vision, concepts, and strategies, including the organizational and technical architectures and their descriptive components. This information relates to technical architecture requirements development, implementation, standards and guidelines, operations concepts, evolution planning, and implementation strategies. The AD&E is intended for resource managers, developers, integrators, implementors, and USIS users.

Video will need to be added as a part of the overall system, and its role as just another data type will need to be emphasized.

9.2. USIS Technical Architecture Requirements Document (TARD)

The *USIS TARD* document provides a comprehensive listing of the USIS requirements for the USIS enterprise and for each of the digital elements, as identified in the *USIS AD&E*.. These requirements both form the basis for Joint Requirements Documents (JRDs) driving USIS implementation and system definition and support the selection of applicable standards. The requirements within this document are applicable to all organizations responsible for the definition, design, development, implementation, operation, and management of the USIS.

Many new requirements to support video capabilities are identified in this document, so the TARD will need to be updated accordingly. To ease the insertion of additional video requirements, this document is structured along USIS Element lines.

9.3. USIS Standards & Guidelines (S&G)

This document defines the USIS Standards Profile and its context and provides a basis for development, acquisition, integration, and interoperability among USIS systems. The S&G is focused specifically on imagery-specific standards. The standards, conventions, and guidelines defined in the S&G apply to the planning, design, development, test, evaluation, and operation of imagery and imagery related systems comprising USIS.

The S&G will need to be updated to reflect any standards, conventions, and guidelines recommended by this technical report.

9.4. USIS Target 1 (T1) Conops

This document describes the state of the USIS by the Target 1 in the year 2002. This document will need to be updated as a more comprehensive video conops is developed.

9.5. USIS Objective Conops

This document describes the objective state of the USIS in the year 2014. This document will need to be updated as a more comprehensive video conops is developed.

9.6. USIS Standards Profile for Imagery Archives (SPIA)

The SPIA was developed to support interoperability between USIS elements. It addresses information and communications services that are necessary to support the storage, query, location, and retrieval of imagery from digital product archives. Its primary use is its specification of recommended standard data directory elements to be used for imagery libraries.

This document will need to be modified to accommodate video.

9.7. Image Access Services Specification (IASS)

The IASS addresses the core USIS interoperability requirements for imagery and imagery-based products access. The supported operations include image product discovery, metadata attribute retrieval, whole product retrieval, image region retrieval, and client product creation. The IASS defines the Image Access Facility (IAF), Catalog Access Facility (CAF), Profile & Notification Facility (P&NF), and the Imagery Dissemination Facility (IDF) from the CIIF RM.

The facilities defined in the IASS will need to be modified to accommodate video.

9.8. Common Imagery Interoperability Facilities Reference Model (CIIF RM)

The *CIIF RM* specifies a framework for developing an open application program interface (API) between architectural elements of the USIS that will serve both as a technical specification for the eventual development of the individual API definitions, and as a management tool for planning and controlling the work required to develop these facilities. The interface and facility requirements documented within address objective needs of the USIS. The interfaces themselves, based on an object-oriented, distributed computing model similar in concept to the commercial OMG Object Management Architecture, represent device and location independent software-to-software transactions. This document identifies interfaces that address related API functions, and groups them into interface architecture building blocks called “facilities.”

The facilities defined in the CIIF RM will need to be modified to accommodate video.

9.9. Video Image Quality Standards and Guidelines (TBD)

This VIQCB document is currently in work. It will address those standards and guidelines necessary to ensure certain levels of video image quality.

9.10. Defense Airborne Reconnaissance Office (DARO) Common Imagery Ground/Surface System (CIGSS) Acquisition Handbook (CASH)

The CASH specifies a set of standards to support the migration of current imagery ground stations towards a common interoperable baseline and to manage the interoperability of subsequent CIGSS acquisitions.

The CASH will need to be updated to reflect VWG-recommended video standards.

9.11. CIGSS Concept of Operations

This document describes the intended CIGSS operation. There may be high-level updates required to address video.

9.12. Airborne Reconnaissance Technical Architecture (ARTA)

The ARTA specifies a flexible and extensible set of standards and technical guidelines to provide a foundations for interoperability between airborne reconnaissance, C4I, space-based, and other intelligence, surveillance, and reconnaissance (ISR) systems.

Many modifications to support digital video have been incorporated.

9.13. DoD Joint Technical Architecture (JTA)

The JTA mandates the minimum set of standards and guidelines for all DoD Command, Control, Communications, Computers, and Intelligence (C4I) systems acquisitions and includes the interfaces of those systems with other key assets (e.g., weapon systems, sensors, combat support information systems, office automation systems, and models and simulations) to support critical joint warfighter interoperability. The JTA shall be used by anyone involved in the management, development, or acquisition of new or improved C4I systems within DoD.

The JTA will need to be modified to reflect any relevant video-related information in this document.

9.14. Intelligence Community Standards, Conventions, and Guidelines (IC SC&G)

The Intelligence Community Standards, Conventions, and Guidelines provides profiles of the standards, conventions, and guidelines for information system interoperability within the Intelligence Community.

This document will not be updated in any major way, since the imagery specific standards are referenced by the USIS S&G.

10. APPENDIX 1: SUMMARY OF VWG AND SUBGROUP RECOMMENDATIONS

This section lists the decisions and recommendations of the VWG and its subgroups. Only the *decisions* made by the VWG are considered official; all recommendations, including those currently before the VWG, are not considered final.

10.1. VWG Recommendations

10.1.1. Decisions

1. MPEG-2 has been adopted for video compression

10.1.2. Recommendations pending further review

1. Adopt MPEG-2 4:2:2 Profile @ Main Level
2. Adopt SMPTE 259M 10-bit CCIR 601 for exploitation center-grade video

10.2. VMG General Recommendations

1. Adopt SMPTE Drop Frame VITC
2. Create a core data set with minimal required metadata to support basic archive, mapping, mensuration, and exploitation functions
3. Mandate core data set be maintained throughout the imagery cycle
4. Use Line 21 CC as primary carrier of core data elements
5. Establish a configuration control body to maintain an archive of lookup tables (LUTs) and math models
6. Develop initialization, checkout, and test (IC&T) functions for video metadata
7. Establish certifying body to perform IC&T against exploitation requirements
8. IC&T body evaluate geometry models and mensuration programs
9. Standardization a measurement application (such as, but not necessarily, Ruler)

10.3. VIQCB Recommendations

1. Recommendations are TBS

10.4. VAD Recommendations

1. Establish video units convention
2. Additional recommendations are TBS

10.5. VERAD Recommendations

1. Recommendations are TBS

11. APPENDIX 2: TECHNICAL DETAILS

The following sections contain relevant technical information on video.

11.1. Video Formats

A video format actually comprises scanning format and color encoding. The scanning format comprises the number of active horizontal samples (pixels), vertical lines, the refresh rate, and interlacing. The US standard is 525 2:1 interlaced lines, each with 720 horizontal samples, refreshed at a rate of 59.94 fields per second; the non-integral field refresh rate is a remnant of early TV system engineering to overcome 60 Hz interference from electric power, a problem that has since been solved in other ways.

Interlaced TV, as illustrated in Figure 9, comprises two fields of alternating physical scan lines; the first field is called odd and the second even. The two fields taken together compose a single video frame. Note that the field refresh rate is twice the frame refresh rate.

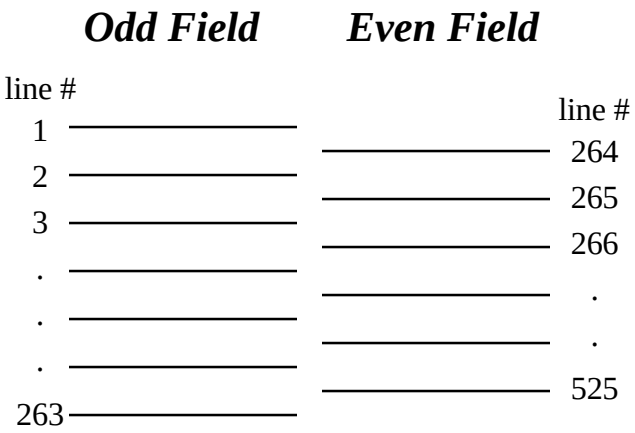


Figure 9. Interlacing

A color encoding format defines how the colors are represented. In general, the color is expressed as either a composite and component signal. Color video cameras collect three separate channels to represent the data. If these three channels are combined into a single signal, as for standard TV, the result is a composite signal. Although equipment is generally less expensive to support a composite signal, the quality suffers irreversible artifacts; this can complicate editing and image enhancement. Component signals maintain each channel separately. The standard for US TV composite color encoding is referred to as NTSC. Component color encoding includes $Y'C'_bC'_r$, which defines a luma channel and two color difference chroma channels. Two-channel component (Y/C) equipment is also available and combines the C'_b and C'_r channels; this provides slightly less quality than the three-channel component.

One form of compression commonly used in the video camera itself is chroma subsampling. Because the human eye is more sensitive to luminance (brightness) than chrominance (color), some of the chroma signal can be discarded without noticeable results. Fully-sampled signals yielding superior studio-quality performance (and high priced equipment) are denoted 4:4:4. Most studios use the less expensive, high quality 4:2:2 video,

in which both color difference channels (C_b and C_r) have been horizontally subsampled by a factor of two. Typical consumer-quality video is 4:2:0, where the color difference channels have been both horizontally and vertically subsampled by a factor of two.

11.2. Vertical Blanking Interval (VBI)

The VBI comprises lines 1 - 21 (odd field)/264 - 284 (even field) in a TV broadcast signal. Portions of the VBI are used for timing, but lines 10 - 21 are unused, and available for the broadcaster to insert information. There are no firm requirements to protect any of the unassigned fields, but there are general agreements concerning line assignment. Line 21 is typically used for CC, while the SMPTE time code typically occupies either Line 14 or Lines 16 and 18.

11.3. Closed Captioning (CC)

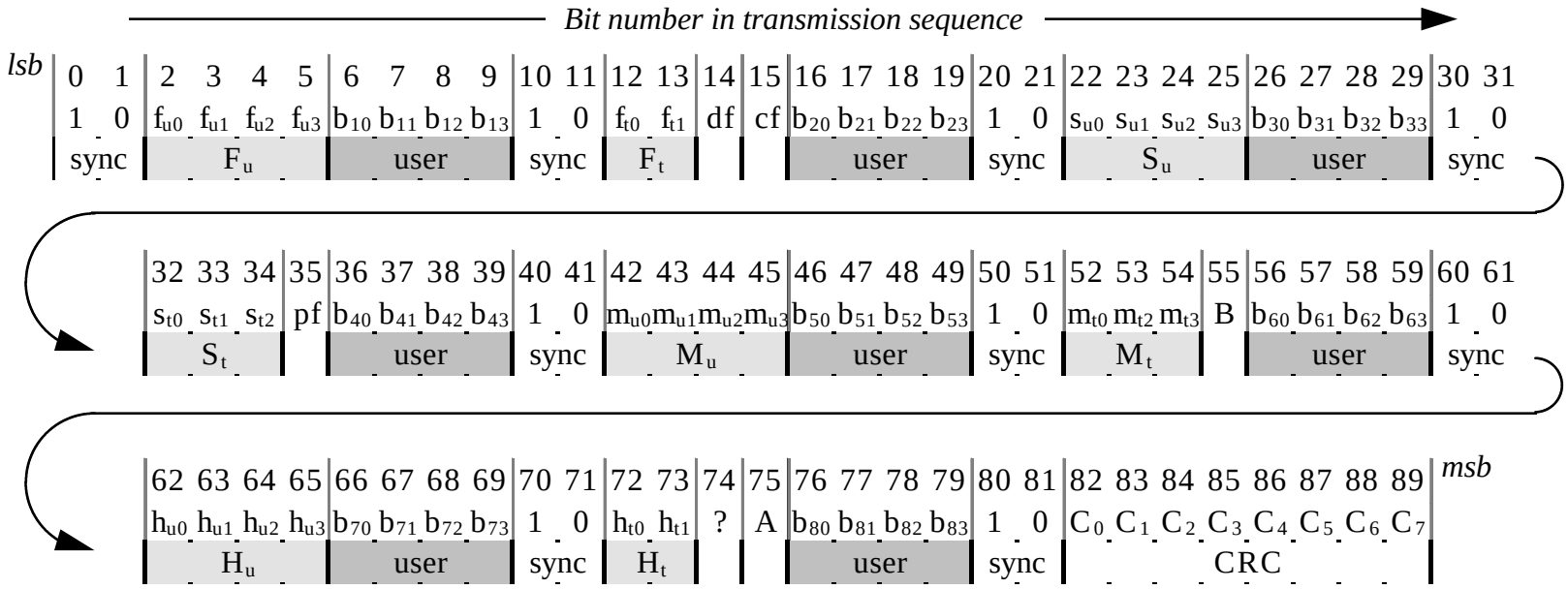
Line 21 CC provides 60 B/s, or 1B/field, of user data transfer. This is much less than the actual capacity of the signal to accommodate video tape recorder (VTR) synchronization sensitivities.

11.4. SMPTE Time Code

SMPTE has defined time codes to be used for unique frame identification to support editing within a given program, either on tape, film, or broadcast. Two types are defined: longitudinal time code (LTC) and vertical interval time code (VITC). VITC is the preferred time code for USIS video because LTC cannot be read while a tape is operating in slow motion or paused. The VITC structure is illustrated in Figure 10.

SMPTE time code typically occupies VBI line 14 for TV broadcast and lines 16 and 18 for tape applications.

In addition, since standard US TV has a non-integral frame refresh rate, and the frames are represented by integral numbers, a technique known as drop frame must be implemented to ensure that the frames have the proper time. Every frame 00:00 and 00:01 at the start of every minute, except the tenth, is dropped.



Legend

User Bits	
b_{xy}	user bits binary group x: group # (1-8) y: bit # (0 - 3)

Control Code	
df	drop frame flag
cf	color frame flag
pf	parity/field mark
A	binary group A
B	binary group B
?	unassigned
CRC	Cyclic Redundancy Check

Time Code		
f_{xy}	frame	x: u = units
s_{xy}	second	t = tens
m_{xy}	minute	
h_{xy}	hour	y: bit # (0 - 3)

binary group flags		
A	B	
0	0	Unspecified data
0	1	ISO 646/2202 8-bit chars
1	0	SMPTE RP 135-1990 data
1	1	Unassigned

Figure 10. Vertical Interval Time Code (VITC) Structure

11.5. Video Transfer Modes

There are three different ways to transfer video data, as illustrated in Figure 11: real-time feed, server playback, or file transfer. Each has different timing requirements.

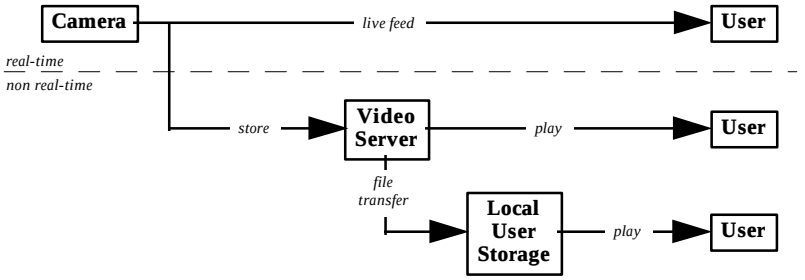


Figure 11. Video Playback Methods

11.6. MPEG-2 Technical Summary and Background

MPEG-2 specifies audio and video compression, as well as a multiplexing method for the audio, video, and private data streams. Figure 12 illustrates how these streams are combined.

MPEG-2 defines logical packetized elementary streams (PES) that support video, audio, or data streams, with variable packet sizes. PES packets are multiplexed into program or transport streams.

A program stream (PS) combines one or more PES streams with a common time base (for example, a video program with an audio track) into a single stream. A transport stream (TS) combines one or more *programs* with different (independent) time bases and can also multiplex individual video, audio, or data PES.

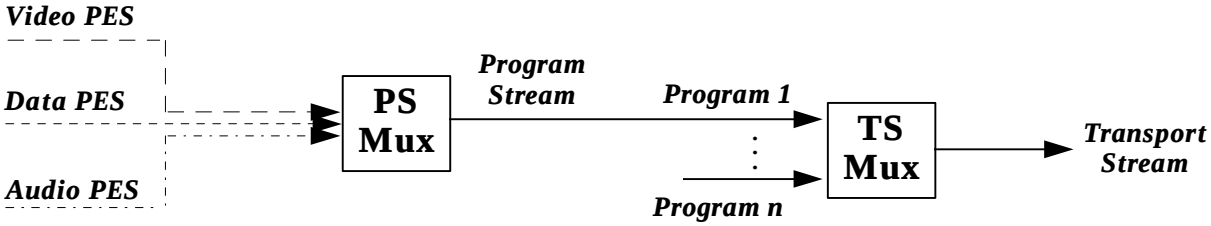


Figure 12. MPEG-2 Stream Multiplexing

MPEG-2 can support metadata transport two different ways: (expandable) private data streams, which allow the greatest quantity of data to be carried, and approximately 100 user bytes, which are located in various parts of the video stream itself. Although there is far more capacity in the private data stream, the user bytes are actually part of the video signal. Currently, in neither case is data protection guaranteed, as different manufacturers use these locations for other data.

11.7. Recording Formats

There are several digital and digitized analog video recording formats available today.

11.7.1. D1

D1 tapes can store 94 minutes of digital component video (CCIR 601 4:2:2) on 19 mm tapes. D1 is the top-of-the-line tape format, with minimal generational loss, but is in limited use due to the expensive equipment. D1 tape physical properties, format, and content are defined in SMPTE standards 224M, 225M, 226M, 227M, and 228M.

11.7.2. D2

D2 tapes can store 208 minutes of digital composite video (NTSC/PAL) on 19 mm tapes. The D2 format is incompatible with D1. D2-formatted data is susceptible to typical composite artifacts, such as color crossover and contouring. D2 tape physical properties, format, and content are defined in SMPTE standards 226M, 244M, 245M, 247M, and 248M.

11.7.3. D3

D3 tapes can store up to 245 minutes (depending on the tape length) of digitized composite video (NTSC/PAL) on 1/2" tapes. D3 also suffers typical composite artifacts. D3 tape physical properties, format, and content are defined in SMPTE standards 263M, 264M, and 265M.

11.7.4. D5

The D5 tape format supports digital component video (CCIR 601 4:2:2, 10 bit) on 1/2" tapes. D5 tape physical properties, format, and content are defined in SMPTE standards 263M and 279M.

11.7.5. D6

The D6 tape format has been recently proposed and will support various digital video and audio data standards up to 1 Gb/s. D5 tape physical properties, format, and content are defined in SMPTE standards 277M and 278M.

11.7.6. Digital Betacam

Digital Betacam stores digital component video (CCIR 601 4:2:2) data, compressed 2:1 using intrafield compression.

11.7.7. Digital Video Cassette (DVC)

DVC is a new digital component video (4:1:1 or 4:2:0) tape format using 5:1 intrafield DCT compression.

12. ANALOG VIDEO STANDARDS

While analog video should not be implemented in lieu of digital, existing analog systems will need to migrate to digital video. This section describes some of the analog video standards that will need to be dealt with in the interim.

12.1. SMPTE 170M-1994: Composite Analog Video Signal - NTSC for Studio Applications

Also known as RS-170, this standard defines studio-grade analog color composite video signals for both analog and digital NTSC equipment interfacing. The scanning standard used is 525/59.94, the color encoding is NTSC, 2:1 interlace, and a 4:3 aspect ratio.

13. APPENDIX 3: ANALOG SYSTEMS

13.1. Predator

The Predator Advanced Concept Technology Demonstration (ACTD) UAV system carries a variety of sensors, including a video sensor. This platform is providing real time lessons learned on UAV video.

The exploitation support data (ESD) proposal outlined below is not the official VWG recommendation. Rather, it is provided as an operational example of how an implementation might be developed.

13.1.1. Predator ACTD ESD Proposal

This section contains the current plan for the content, format, sequencing, and transmission frequency of Predator ESD products to be embedded into the video Vertical Blanking Interval (VBI). Note that this is not the final version.

At least one screen containing frequently changing data, such as date, mission number, vehicle number, and GCS location will be displayed at the beginning of a transmission for about one minute.

A copy of all data stored in the CC, along with parsing tables, will be repeated in the CC-2 section of the VBI. The user then has the choice of selecting either CC-1 to display the metadata on a monitor, or CC-2 for parsing them with a computer.

Future experiments will include using the VBI text feature, which has greater capacity but is less robust (for recording survivability) and requires decoders of greater cost and complexity than those needed for CC-2—CC-1 decoders are standard on virtually all modern TVs.

The proposed data elements for the Predator ACTD are

- Vehicle Lat/Long
- Sensor ID
- Vehicle Attitude
- Vehicle Heading
- Image Center Lat/Long
- Time of Day
- Payload Azimuth
- Slant Range
- Distance at Image Base

In the future, additional data elements will be added, such as Date, Mission Number, Vehicle Number, and GCS Location.

(TBS) Additional information to be supplied includes the Proposed Layout of Data Contents, which shows the kind of information and how it is proposed to appear on TV monitors receiving the Closed Caption (CC-1) signal from Predator; Proposed Layout of Data

Format, which shows a sample of the proposed display as well as the units of dimensions provided; and a Transmission Sequence Budget, which shows the scheduled (periodic) transmission time for each character.

13.2. Hunter UAV

The Hunter is another UAV platform that carries a video sensor. More information is TBS.

13.3. Handheld

Handheld video assets are another type of video sensor that will feed into the USIS. Additional information is TBS.

13.4. Joint Tactical (JT) UAV

Additional information is TBS.

13.5. Tactical Control System (TCS)

Additional information is TBS.

13.6. P3 Aircraft

Additional information is TBS.

13.7. Gun Camera

Gun camera includes sensors that are mounted on vehicles for purposes of monitoring BDA. Additional information is TBS.

14. APPENDIX 4: TARD SERVICES AND EXISTING VIDEO REQUIREMENTS

This section lists individual element services and all levels of related video requirements from the TARD specified in Section 2. Refer to the TARD for a complete listing of all requirements.

Table 9. Management Element

Management Element: TARD Services		
3.1.1	Nomination Management Services	
3.1.1.1	Imagery Nomination Definition Registration Service	
3.1.1.2	Assignment Planning Service	
3.1.1.3	Requirement Activation and Assignment Service	
3.1.1.4	Dissemination Request Generation Service	
3.1.1.5	Nomination Processing Monitoring Service	
3.1.1.6	Resource Monitoring Service	
3.1.1.7	Requirement Accomplishment Monitoring Service	
3.1.1.8	Application Management Service	
3.1.2	Repository Management Services	
3.1.2.1	Discovery Services	The Management Element shall provide the capability for a user to discover the existence of any or all USIS library contents through interactive services consisting of global catalog search, global free-text search, and global directory browse as specified in the following subparagraphs.
3.1.2.2	Global Profiling Service	The Management Element shall provide the capability to initiate the automatic dissemination of a given item to a user, or notify the user of the item's existence, based on a predefined set of user-specified criteria.
3.1.2.4	Library Management Service	
3.1.2.5	Application Management Service	
3.1.3	Delivery Management Services	
3.1.3.1	Brokered Retrieval Service	The Management Element shall provide the capability to serve as broker between a user and multiple Libraries that contain the requested Product_Data_Item, such that the retrieval is directed to a Library that provides the most timely response, as specified in the following subparagraphs.
3.1.3.2	Delivery Planning Service	
3.1.3.3	Dissemination Requirement Generation Service	
3.1.3.4	Delivery Accomplishment Monitoring Service	
3.1.3.5	Delivery Asset Monitoring Service	
3.1.3.6	Application Management Service	

3.1.4	Executive Management Service (TBR057)	
3.1.4.1	Services (TBR058)	
3.1.4.2	Access Control Services (TBR059)	
3.1.4.3	Audit Trail Services (TBR060)	
3.1.4.4	Sector Correlation Services (TBR061)	
3.1.4.5	User Interface Services (TBR062)	

Table 10. Collection Element

Digital Collection Element: TARD Services and Existing Video Requirements		
3.2.1	Imagery Collection Services	A Collection element shall be capable of collecting Unprocessed_Digital_Imagery in accordance with Collection_Tasking. The various types of collection are described in the following subparagraphs.
3.2.1.1	Electro-Optical (EO) Collection Services	A Collection Element with electro-optical (EO) sensor functionality shall provide unprocessed imagery in one or more of the following spectral band(s).
3.2.1.2	Synthetic Aperture Radar (SAR) Collection Services	A Collection Element with synthetic aperture radar (SAR) sensor functionality shall provide unprocessed imagery using active radar pulses.
3.2.1.3	Video Collection Services	A Collection Element with video capability shall collect and provide Video_Imagery in accordance with Collection_Tasking.
3.2.1.3.1	Black and White (B&W) Video Collection	A B&W video Collection Element shall collect video imagery using a panchromatic video camera.
3.2.1.3.2	Color Video Collection	A color video Collection Element shall collect video imagery using a color video camera.
3.2.1.3.3	Infrared (IR or FLIR) Video Collection	A IR or FLIR video Collection Element shall collect video imagery using a forward looking infrared (FLIR) sensor.
3.2.1.4	Dimensional Collection Services	A Collection Element shall collect imagery such that two and three dimensional products can be constructed from the data.
3.2.1.5	Support Data Services	A Collection Element shall provide associated exploitation and processing support data for all imagery collected such that all necessary collection characteristics and parameters are available for processing, exploitation, and metadata generation.
3.2.1.6	Collection Platform Services	A Collect Element shall use with various platforms to support the imaging sensor.
3.2.1.7	Area Collection Quantity Services	The total of all Collect Elements shall collect imagery in a continuous and synoptic manner covering the total area listed in the following sub-paragraphs each day. Measurements are made in thousands of square nautical miles (ksqnm).
3.2.1.8	Point Target Collection Quantity Services	The total of all Collect Elements shall collect imagery of the number of point targets per day listed in the following sub-paragraphs.
3.2.1.9	Video Quantity Collection Services	The total of all Collect Elements shall collect video imagery with a aggregate duration from multiple collectors of 100 hours (TBR065) duration per day.
3.2.1.10	Area Collection Quality Service	The total of all Collect Elements shall collect continuous and synoptic area imagery for the given image quality parameters, that covers the ground area per day as stated in the following sub-paragraphs. Measurements are made in thousands of square nautical miles (ksqnm).

3.2.1.11	Point Target Collection Quality Services	The total of all Collect Elements shall collect imagery of the required interpretability quality factors for the number of point targets per day listed in the following sub-paragraphs.
3.2.1.12	Video Collection Quality Services	The total of all video Collect Elements shall collect imagery of the required quality interpretability factor (or video-NIIRS if it is established).
3.2.1.12.1	Video Resolution	The Collection Elements shall provide video resolution ranging from 240 by 480 pixels to 2,048 by 2,048 (TBR066) pixels per frame.
3.2.1.12.2	Video Field of View	A Collection Element shall provide video sensor field of view (FOV) from 0.5 degrees to 20 (TBR067) degrees.
3.2.1.12.3	Video Frame Rate	A Collection Element shall provide video at frame rates ranging from 60 frames a second to 1 frame a minute as commanded by the operator.
3.2.1.12.4	Video Vibration	A Collection Element shall provide video imagery such that vibration, jitter, and other imaging errors contribute smear of less than 0.4 (TBR068) μrad angular error or 5 (TBR069) μm displacement at the focal plane.
3.2.1.12.5	Video-NIIRS (TBR070)	A Collection Element shall provide video imagery rated by a national imagery interpretability rating scale for video once one is developed. Meeting the requirements for Video-NIIRS may supersede the other requirements of section 3.2.1.12.
3.2.1.13	Target Geo-positioning Services	A Collection Element shall provide imagery such that the locations of targets may be geo-located with the accuracy stated in the following sub-paragraphs.
3.2.1.14	Imagery Mensuration Services	A Collection Element will provide imagery such that the mensuration and warping of area collections may be accomplished to within [CRQ 3.2.1.14] of the WGS-84 geoid.
3.2.1.15	Imagery Targeting Services	The Collection Elements shall provide imagery with target (point and area targets) constraints and conditions as stated in the following sub-paragraphs.
3.2.1.16	Imagery Tasking Response Services	A Collection Element shall provide tasking to platform and sensor assets within timelines as measured from receipt of Collection_Requirement to time of sensor operation and imaging, as noted in the following sub-paragraphs.
3.2.1.17	Imagery Re-tasking Response Services	A Collection Element shall provide re-tasking to platform and sensor assets in near real time for support of military operations (SMO) and other high priority targets.
3.2.1.18	Delivery of Imagery to Processing Sites	A Collector Element shall distribute Unprocessed_Digital_Imagery acquired by collection assets and deliver it to processing sites within timelines noted in the following sub-paragraphs. Timelines are measured from sensor operation to the delivery of the Unprocessed_Digital_Imagery to the processing element.
3.2.1.19	Event Observation Services	A Collection Element shall provide imagery in response to tasking for a specific given sensor acquisition time, duration, and geographic to observe an event at that location.
3.2.1.20	Sensor Data Interface Service	A Collection Element shall provide Unprocessed_Digital_Imagery in the specific sensor and platform data interface standards and formats to the Processing Element.
3.2.1.21	Processing Support Data Interface Service	A Collection Element shall provide associated processing support data in the specific sensor and platform data interface standards and formats to the Processing Element.
3.2.1.22	Exploitation Support Data Interface Service	A Collection Element shall provide associated exploitation support data in the specific sensor and platform data interface standards and formats to the Processing Element.
3.2.1.23	Video Sensor Data Interface	A Collection Element shall provide Video_Imagery to the Processing Element in accordance with USIS Standards & Guidelines.

3.2.1.24	Classification Service	A Collection Element shall provide classification information for all data to the Processing Element and Management Element.
3.2.2	Collection Management Services	A Collection element shall provide the capability to manage the operation of collection assets and interfaces to the other USIS elements and the Management Elements to exchange control and status information. The various types of collection management services and functions are described in the following subparagraphs.
3.2.2.1	Collection Planning Service	A Collection Element shall provide various type of planning for the Collection Element and for interaction with other USIS elements as described in the following subparagraphs.
3.2.2.2	Collection Tasking Service	
3.2.2.3	Collection Resource and Status Service	A Collection Element shall interface with the Management Element to exchange control and status information as described in the following subparagraphs.

Table 11. Processing Element

Processing Element: TARD Services and Existing Video Requirements		
3.3.1	Imagery Processing Service	A Processing Element shall provide the capability to create Digital_Imagery by a mathematical process using Unprocessed_Digital_Imagery data.
3.3.1.1	Process Electro-Optical Imagery Service	A Processing Element shall provide the capability to create imagery from electro-optical sensors.
3.3.1.2	Synthetic Aperture Radar (SAR) Imagery Processing Service	A Processing Element shall provide the capability to create imagery from synthetic aperture radar sensors.
3.3.1.3	Video Imagery Processing Service	A Processing Element shall provide the capability to create imagery from video cameras.
3.3.1.3.1	Digital Video	A Processing Element shall provide the capability to process Video_Imagery and create the required Digital_Video_Imagery.
3.3.1.3.2	Video Frame Capture	A Processing Element shall provide the capability to process Video_Imagery and create single frame digital still imagery in accordance with USIS Standards & Guidelines document, section 4.
3.3.1.4	Quantity Processing Service	The aggregate of the Processing Elements shall provide the capability to process [CRQ 3.3.1.4] terapixels of imagery per day.
3.3.1.5	Quality Processing Service	A Processing Element shall provide image quality enhancement.
3.3.1.6	Target Geo-Positioning Services	A Processing Element shall process imagery such that the locations of targets may be geo-located with the accuracy stated in the following sub-paragraphs.
3.3.1.7	Mensuration Services	A Processing Element will process imagery such that the mensuration and warping of area collections may be accomplished to within [CRQ 3.3.1.7] of the WGS-84 geoid.
3.3.1.9	Video Imagery Interface	A Processing Element shall deliver Video_Imagery to global communications in near real time for support of military operations (SMO) and other high priority targets.
3.3.1.10	Sensor Data Interface	A Processing Element shall receive Unprocessed_Digital_Imagery in accordance with multiple sensor interfaces from the Collection Elements.
3.3.1.11	Processing Support Data Interface	A Processing Element shall receive associated processing support data from the Collection Elements.
3.3.1.12	Exploitation Support Data Interface	A Processing Element shall receive associated exploitation support data from the Collection Elements.

3.3.1.13	Imagery Interface	A Processing Element shall provide Digital_Imagery in accordance with USIS Standards & Guidelines document, section 4.
3.3.1.14	Digital Video Imagery Interface	A Processing Element shall provide Digital_Video_Imagery to the Global Communications Element in accordance with the USIS Standards and Guidelines document.
3.3.2	Imagery Processing Management Services	A Processing Element shall provide the capability to manage the operation of processing assets. A Processing Element shall interface to the other USIS elements and the Management Element to exchange control and status information.
3.3.2.1	Processing Planning Service	A Processing Element shall provide planning for the processing assets and for interaction with other USIS elements as described in the following subparagraphs.
3.3.2.2	Processing Tasking Service	A Processing element shall receive Processing_Requirements from the Management Element and generate the requests to the appropriate Processing Support Services based on specifications in the requirements as described in the following subparagraphs.
3.3.2.3	Processing Resource and Status Service	A Processing Element shall determine, maintain, and report processing facility, system, and personnel current operational readiness capability as a percent of full operational capability to the Management Element.

Table 12. Dissemination Element

Dissemination Element TARD Services and Existing Video Requirements		
3.4.1	User-Accessible Dissemination Services	A Dissemination Element shall provide a user and/or operator access to the element's functions through a set of user-accessible services as specified in the following subparagraphs.
3.4.1.1	Dissemination Service	A Dissemination Element shall provide the capability to initiate the processes to disseminate processed imagery and imagery products.
3.4.1.2	Reprioritization Service	A Dissemination Element shall provide the capability for a user and/or operator to reprioritize the imagery and imagery products in a dissemination queue prior to transmission of the data.
3.4.2	Dissemination Support Services	A Dissemination Element shall provide Dissemination Support Services for extracting and addressing imagery and imagery products as specified in the following subparagraphs.
3.4.2.1	Extraction Service	A Dissemination Element shall provide the capability to extract user-specified sub-arrays from imagery and generate reduced resolution data sets from imagery and imagery products for subsequent dissemination as specified in the following subparagraphs.
3.4.2.2	Addressing Service	A Dissemination Element shall address imagery and imagery products for subsequent dissemination as specified in the following subparagraphs.
3.4.2.3	Dissemination Queue Service	A Dissemination Element shall provide the capability to queue imagery and imagery products until sufficient communications bandwidth is available to transmit the data.
3.4.3	Dissemination Data Management Service	A Dissemination Element shall provide an operator or system administrator the capability to manage data in prioritized dissemination queues prior to transmission.
3.4.3.1	Queue Maintenance Service	A Dissemination Element shall have the capability to manage data in prioritized dissemination queues with at least 6 priority levels per queue.
3.4.4	Dissemination Process Monitoring Service	A Dissemination Element shall monitor the performance of its services by collecting, processing, and reporting statistical data as specified in the following subparagraphs.
3.4.5	Dissemination Resource Management Service	A Dissemination Element shall be capable of managing the dissemination queues that are resident on the Site Infrastructure Element.

3.4.6	Enterprise Management Support Service	A Dissemination Element shall interface with the Management Element to exchange control and status information.

Table 13. Library Element

Library Element: TARD Services and Existing Video Requirements		
3.5.1	User-Accessible Library Services	A Library shall provide a user or operator access to the Library's functions and data through a set of user-accessible services as specified in the following subparagraphs.
3.5.1.1	Import Services	A Library shall provide the capability to import new data for storage and subsequent retrieval.
3.5.1.2	Discovery Services	A Library shall provide a user the capability to discover the existence of specific local Library contents through interactive services consisting of catalog search, text search, and directory browse as specified in the following subparagraphs.
3.5.1.3	Local Profiling Service	A Library shall provide the capability to initiate the automatic dissemination of a given item to a user, or notify the user of the item's existence, based on a predefined set of user-specified criteria.
3.5.1.4	Retrieval Services	A Library shall provide the capability to specify the retrieval of Library contents and receive a response in the form of the stored data, as specified in the following subparagraphs.
3.5.2	Library Support Services (TBD019)	
3.5.3	Data Management Services	The Library shall provide an operator or system administrator the capability to maintain the data in the local catalogs and directories as specified in the following subparagraphs.
3.5.4	Library Process Monitoring Service	A Library shall monitor the performance of its services by collecting, processing and reporting statistical data as specified in the following subparagraphs.
3.5.5	Library Resource Management Service	A Library shall provide the capability to manage the imagery and imagery products residing on the Site Infrastructure Element resources.
3.5.6	Library Enterprise Management Support Services (TBS001)	A Library shall provided the capability to accept control inputs and provide status to the Management Element on the state of the Library processes and resources.

Table 14. Exploitation Element

Digital Exploitation Element TARD Services and Existing Video Requirements		
3.6.1	User-Accessible Exploitation Services	A Digital Exploitation Element shall provide a user and/or operator access to the element's functions through a set of user-accessible services as specified in the following subparagraphs.
3.6.1.1	Task Package Assembly Service	A Digital Exploitation Element shall provide the capability to automatically and interactively assemble data in support of the effective and timely execution of exploitation tasks.
3.6.1.2	Task Package Display Service	A Digital Exploitation Element shall be capable of displaying any item or coordinated set of items associated with a task package, and of presenting such displays simultaneously at different workstations for collaborative purposes using the Support Applications Services of the Site Infrastructure Element.[2]
3.6.1.3	Image Manipulation Service	A Digital Exploitation Element shall include the capability to perform standard mathematical image transformations of image data.
3.6.1.4	Image Enhancement Service	A Digital Exploitation Element shall include the capability to enhance the apparent conditions that define a image of a particular scene.
3.6.1.5	Mensuration and Estimation Service	A Digital Exploitation Element shall include capabilities for mensuration and for estimation of key variables related to scene and imaging conditions.
3.6.1.6	Recognition Service	A Digital Exploitation Element shall provide a user the capability to interactively and automatically generate new information from imagery based on the contents of the scenes imaged.
3.6.1.7	Model Manipulation Service	A Digital Exploitation Element shall include the capability to perform standard mathematical model transformations of model data.
3.6.1.8	Annotation Service	A Digital Exploitation Element shall provide the capability to associate new information of a variety of types with existing task package items.
3.6.1.9	Build Product Service	A Digital Exploitation Element shall provide the capability to generate new items for inclusion in a task package.
3.6.1.10	Production Support Service	A Digital Exploitation Element shall provide a set of editors that support production of all the types of items that may comprise a task package item.
3.6.1.11	Exploitation Profiling Service	A Digital Exploitation Element shall provide the capability submit Catalog Search Requests, Library Retrieval Requests and Filter Scripting Requests based on a predefined set of user specified criteria.
3.6.2	Exploitation Support Services	(TBS002)
3.6.3	Exploitation Data Management Services	
3.6.3.1	Product Release Service	A Digital Exploitation Element shall provide a service that checks final security, quality, format, and other release requirements, and dispatches the product to the customer and Image Product Library if the requirements are fulfilled.
3.6.4	Exploitation Process Monitoring Services	(TBS003)
3.6.5	Exploitation Resource Management Services	A Digital Exploitation Element shall provide the capability to interactively and automatically generate, modify, maintain, and execute exploitation task plans at every level of the exploitation organization.
3.6.5.2	Workload Management Service	A Digital Exploitation Element shall provide interactive capabilities that support the analyst in managing the queue of tasks assigned to him/her.

[2] *Collaborative display and manipulation is covered in Section 3.7.2.1.4. Site Infrastructure requirements for collaboration facilities support e-mail, groupware, situation rooms, shared white boards, and video teleconferencing.*

3.6.6	Exploitation Enterprise Management Services	
3.6.6.1	Operations Management Service	The Manage Operations service of a Digital Exploitation Element shall be capable of providing organization-level availability and capability statistics and status for the effective management of USIS Enterprise operations.

Table 15. Site Infrastructure Element

Site Infrastructure Element TARD Services and Existing Video Requirements		
3.7.1	Platform Services	
3.7.1.2	System Control Services	
3.7.1.2.1	Hardware and Software Control Services	A Site Infrastructure Element shall provide standard computer operating system services including but not limited to: process control and scheduling functions, device-driven functions, back-up and restart services, transaction routing and control services, interoperability support mechanisms, system management functions and communications interfaces.
3.7.1.2.2	Administrative Control Services	A Site Infrastructure Element shall provide standard computer operating system administrative services including but not limited to: user maintenance, accounting and auditing, output services, data backups and network connectivity.
3.7.1.3	Security Services	
3.7.1.3.3	Integrity	
3.7.1.3.4	Security Management	
3.7.1.3.4.1	Security Services	A Site Infrastructure Element shall provide services and resources to configure, maintain, and review security services, mechanisms, and resources.
3.7.1.3.4.2	Security-Relevant Services	A Site Infrastructure Element shall provide services and resources to configure, maintain, and review security-relevant services, mechanisms, and resources.
3.7.2	Application Services	
3.7.2.1	Support Applications Services	A Site Infrastructure Element shall provide support application services to be utilized by a wide variety of users and scaleable to support a wide range of imagery-related activities and functions.
3.7.2.1.2	Format Conversion Service	A Site Infrastructure Element shall provide digital conversion tools applicable to imagery and imagery-related data as specified in the following subparagraphs.
3.7.2.1.3	Compression Service	A Site Infrastructure Element shall provide imagery and imagery-related data compression/expansion as specified in the following subparagraphs.
3.7.2.1.4	Collaboration	A Site Infrastructure Element shall provide for cooperative activity including, but not limited to, real-time audio and video, among intra- and inter-site participants.
3.7.2.1.5	Multimedia Capabilities	A Site Infrastructure Element shall provide multimedia capabilities.
3.7.2.1.5.2	Video	A Site Infrastructure Element shall provide video capabilities to include recording and playback.
3.7.3	External Environment Services	
3.7.3.1	External Communications Services	A Site Infrastructure Element shall provide intrasite communications connectivity and bandwidth to support the transfer of imagery data.
3.7.3.2	Display Services	A Site Infrastructure Element shall provide display screens with screen sizes and resolution attributes that are suitable for imagery manipulation and viewing.

3.7.3.3	Storage Services	A Site Infrastructure Element shall provide the capability to store imagery and imagery-related data that is readily accessible.
3.7.3.4	Media Generation Services	A Site Infrastructure Element shall provide the capability to convert textual, imagery and imagery-related data to hardcopy, digital and short-term storage formats.
3.7.3.4.1	Hardcopy Services	A Site Infrastructure Element shall provide the capability to create hardcopy representations of both textual and imagery-derived products.
3.7.3.4.2	Digital Services	A Site Infrastructure Element shall provide the capability to create digital representations of both textual and imagery-derived products.

Table 16. Global Communications Element

Global Communications Element TARD Services		
3.8.1	Data Transport Services	A Global Communications Element shall provide the capability to accept, transmit, and deliver digital imagery, imagery products, and imagery-related data via end-to-end digital connectivity between common global communications access points. The Global Communications Element shall interface with the Site Infrastructure Element and authorized non-USIS entities at those common access points.
3.8.1.3.5	Transmission Security Services	A Global communications element shall support "imagery data" multi-level security requirements, including those for sensitive but unclassified information and multiple categories of classified information between access points.

15. APPENDIX 5: ACRONYMS AND ABBREVIATIONS

3D	Three-dimensional
ACTD	Advanced Concept Technology Demonstration
AD&E	Architecture Definition and Evolution document
ANSI	American National Standards Institute
API	Application Program Interface
ARTA	Airborne Reconnaissance Technical Architecture
BDA	Bomb Damage Assessment
bpp	bits per pixel
B/s	bytes per second
CAF	Catalog Access Facility
CASH	CIGSS Acquisition Handbook
CC	Closed Captioning
CCIR	International Radio Consultative Committee (now ITU-R)
CIGSS	Common Imagery Ground/Surface System
CIIF	Common Imagery Interoperability Facilities
Conops	Concept of Operations
COTS	Commercial Off-the-Shelf
DARO	Defense Airborne Reconnaissance Office
DoD	Department of Defense
DPCM	Differential Pulse Coded Modulation
EG	Engineering guideline (from SMPTE)
EIA	Electronic Industries Association
EO	Electro-optical
ESD	Exploitation Support Data
FBIS	Foreign Broadcast Information Service
FCC	Federal Communications Commission
fps	frames per second
GCCS	Global Command and Control System
GCE	Global Communications Element
HDTV	High-Definition Television
Hz	Hertz (cycles per second)
IAF	Image Access Facility
IC	Intelligence Community
IC SC&G	Intelligence Community Standards, Conventions, and Guidelines document
IC&T	Initialization, Checkout, and Test
IDF	Imagery Dissemination Facility
IEC	International Electrotechnical Commission
IPA	Image Product Archive
IPT	Image Perspective Transform
IR	Infrared
ISO	International Organization for Standardization
ISR	Intelligence, Surveillance, and Reconnaissance
ITU-R	International Telecommunications Union - Radiocommunications

	Sector
JDISS	Joint Deployable Intelligence Support System
JRD	Joint Requirements Document
JTA	DoD Joint Technical Architecture
JT UAV	Joint Tactical UAV
LAN	Local Area Network
lsb	least significant bit
LTC	Longitudinal Time Code
LUT	Lookup Table
Mb/s	Megabits per second (10^6 b/s)
MIDB	Modernized Integrated Database
MIG	MIDB-IPA-GCCS
MPEG	Motion Picture Experts Group
msb	most significant bit
MSI	Multispectral Imagery
Mux	Multiplexer
NEL	National Exploitation Lab
NIMA	National Imagery and Mapping Agency
NIIRS	National Image Interpretability Rating Scale
NTSC	National Television Systems Committee (TV color encoding)
OMA	Object Management Architecture
OMG	Object Management Group
P&NF	Profile & Notification Facility
PAL	Phase Alternate Line (TV color encoding)
PES	Packetized Elementary Stream
PS	Program Stream
QoS	Quality of Service
RFC	Request for Change
RFP	Request for Proposal
R'G'B'	Red, Green, Blue (additive primary colors for light) color representation
RM	Reference Model
RP	Recommended practice (from SMPTE)
RPC	Rapid Positioning Capability
S&G	USIS Standards & Guidelines document
SAR	Synthetic Aperture Radar
SATCOM	Satellite Communications
SDI	Serial Data Interface
SECAM	Sequential Couleur avec Memoire (TV color encoding)
SMPTE	Society of Motion Picture and Television Engineers
SPIA	Standards Profile for Imagery Archives
STU	Secure Telephone Unit
TARD	Technical Architecture Requirements document
TBD	To Be Determined
TBR	To Be Reviewed
TBS	To Be Supplied
TCS	Tactical Control System
TEM	Technical Exchange Meeting
TS	Transport Stream

TV	Television
UAV	Unmanned Aerial Vehicle
USIS	United States Imagery System
VITC	Vertical Interval Time Code
VIS	Visible
VMG	Video Metadata Group
VTC	Videoteleconference
VTR	Video Tape Recorder
VWG	Video Working Group
WWW	World Wide Web
$Y'C'_bC'_r$	Luma and 2-channel chroma component pixel color space (digital)
$Y'P'_bP'_r$	Luma and 2-channel chroma component pixel color space (analog)